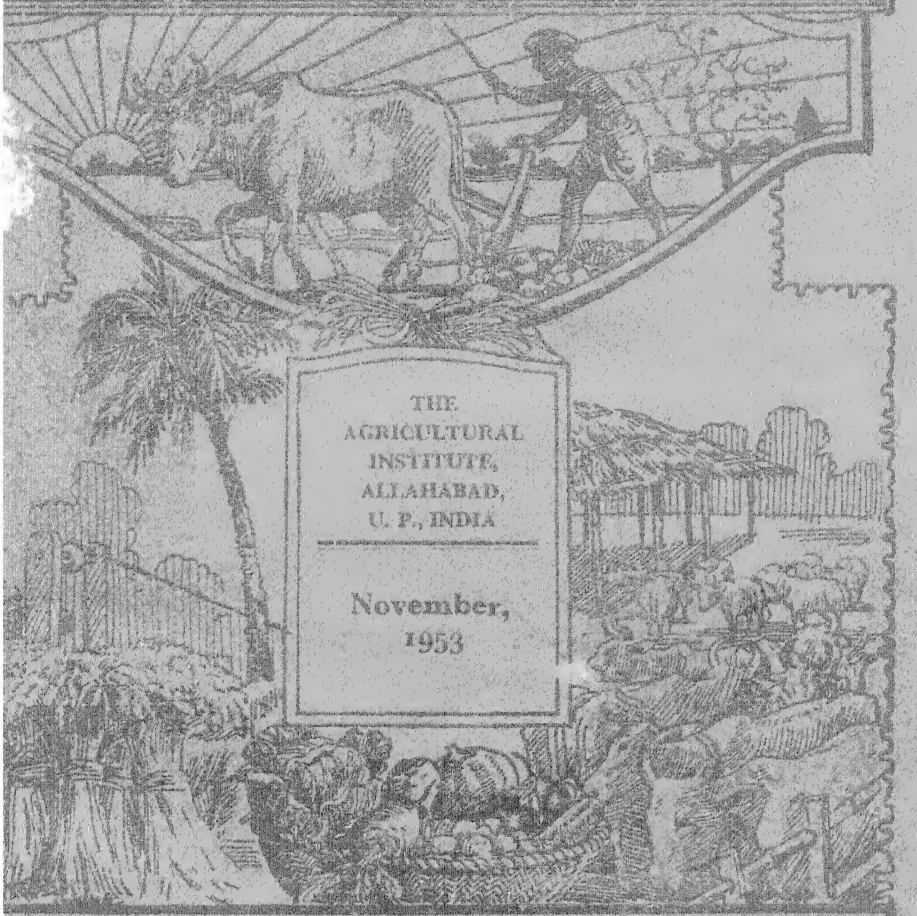
XXVII No. 6

THE ALLAHABAD FARMER

A Bi-monthly Journal
of
Agriculture and Rural Life



THE
AGRICULTURAL
INSTITUTE,
ALLAHABAD,
U. P., INDIA

November,
1953

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In the last paragraph of the Library Report published in the September, 1952 issue of the Farmer, I mentioned the difficulty of maintaining complete files of periodicals and said that in a subsequent number of the Farmer we would publish a list of the publications we need and a list of publications we can offer in exchange or sale. Will the readers of the Allahabad Farmer who are interested in any of these kindly write direct to the Librarian, Agricultural Institute, Allahabad.

List of Periodicals

Part I—Publications Wanted

Indian Farm Mechanization.

1950 **1** Complete volume.
1951 **2** ,, ,,
1952 **3** 1, 2, 3, 5, 7, 9, 12,
1953 **4** 7, 8, 9, 10, 11, 12.

American Journal of Botany

1951 **38** 1, 2, 3, 6, 7.

Phytopathology

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1920 **10** 1, 11.
1936 **26** 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.
1943 **33** 4.
1946 **36** 9.
1949 **39** 6.
1951 **41** 10, 12.
1952 **42** 1, 2, 5, 10, 11.

Review of Applied Mycology.

1950 **29** 2, 12, and Index no.
1951 **30** 5.

Indian Farming.

1946 **7** 7.
1949 **10** 12.
1951 **1** 5, 6. (New Series.)

Indian Journal of Agricultural Science.

1951 **21** 4,
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The Indian Veterinary Journal.

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1942 **18** 4, 5, 6.
1943 **19** 6.

Part II—Publications Offered

Indian Farm Mechanization.

1952 **3** 6.

Indian and Eastern Engineer.

1952 **CX** 2.

American Journal of Botany.

1950 **37** 7.

Phytopathology.

1949 **39** 7.
1950 **40** 4, 7, 12.

The Review of Applied Mycology.

1948 **27** 9.
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Indian Farming.

1940 **1** 1.
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The Indian Veterinary Journal.

1945 **21** 4.
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1950 **27** 1.

Indian Journal of Vet. Sc. and An. Husbandry.

1933 **33** 2, 3, 4.
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U. S. D. A. Year Books.

1942 and 1938.

The Journal of Horticultural Science.

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1951 **49** Complete.
1951 **50** 1, 2.
1952 **51** 2, 4, and Index no.

Journal of Animal Science.

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Science and Culture.

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Indian Journal of Veterinary Science and Animal Husbandry.

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U. S. D. A. Year Books.

1901, 1904, 1913, 1919, 1921, 1922, 1923, 1925, 1928, 1930, 1948.

U. S. D. A. Experiment Station Records.

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1924 **49** 8, 9, and Index no.
1924 **50** 2, 3, 4, 5, 6 and Index no.
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1928 **58** 1, 2, 3, 4, 6, 7, 8, 9.
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1929 **61** 1, 2, 4, 5, 6, 7, 9.
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1932 **67** 3.
1934 **70** 1, 2, 3, 4, 5, 6.
1934 **71** 1, 2, 3, 4, 5, 6 and Index.
1936 **75** 4, 5, 6.
1946 **94** 3, 4.

Biochemical Journal.

1923 **17** Complete.

Revisita Di Agricoltura Subtropicale E Tropicale.

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1952 **46** 4-6, 10-12.
1953 **47** 1-3, 4-6, 7-9.

Der Tropenpflanzer : Zeitschriff das Gesantgebiet der Land und Forstwirtschaft warmer Lander.

1934 **37** 8.
1935 **38** 5, 6, 7, 8, 9, 10, 11, 12.
1939 **42** 1-8.

Allahabad Farmer.

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THE ALLAHABAD FARMER, NOVEMBER, 1953

Subscription of most of our subscribers ends with this number. Kindly send your renewal subscription soon and avoid a V. P. P.

THE ALLAHABAD FARMER

BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE

The ALLAHABAD FARMER is now approved by the Directors of Public Instruction in Uttar Pradesh, West Bengal, Madhya Pradesh, Sind, Assam, Bihar and Orissa, and by the Director of the Institute of Plant Industry, Indore, for use in all schools under their jurisdiction.

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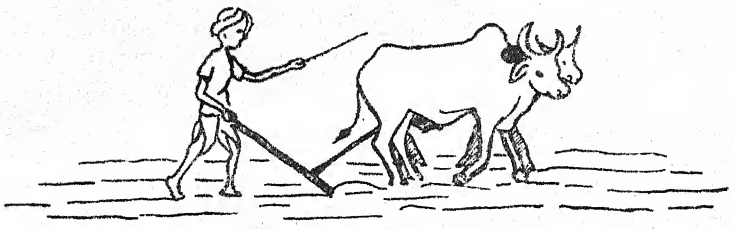

VOL. XXVII | NOVEMBER, 1953 | NO. 6

EDITORIAL

HENRY AZARIAH BECOMES INSTITUTE PRINCIPAL

On October 28, 1953, Henry S. Azariah was inaugurated the fourth principal of the Agricultural Institute, succeeding Arthur T. Mosher. Thus the Institute entered its "second generation", for Mr. Azariah was a student during Dr. Higginbottom's administration. His election by the Board of Directors last March was another milestone in the direction of realizing an important objective; for it has long been determined that the responsibility for directing and developing the work of the Institute shall rest upon Indian shoulders.

After his student days, Mr. Azariah joined the staff in 1936 as a member of the Agricultural Economics Department. Later, he and Mrs. Azariah studied at Cornell University, where Mr. Azariah received a Master's Degree in Agricultural Economics and Mrs. Azariah her Bachelors Degree in Home Economics. During 1951-52, Mr. Azariah was on study leave at the Institute of Agricultural Research at Oxford University. During Dr. Mosher's absence, he served as Acting Principal.

The occasion of Mr. Azariah's inauguration brought guests to the Institute from various parts of the country and a large number from Allahabad itself. The new Principal received greetings from many persons, among them the Institute's founder, Dr. Higginbottom, who recorded his message on tape. Bishop Rockey spoke at a special service of worship in the morning, and in the late afternoon Dr. Augustine Ralla Ram, President of the Board of Directors, conducted the inauguration ceremony. The principal speaker on the occasion was Miss Sarah Chakko, Principal of Isabella Thoburn College.

In his response to the charge given him by Dr. Ralla Ram, Mr. Azariah outlined his hopes and plans for the Institute. His speech is printed on the following page.

J. B.

THE ALLAHABAD AGRICULTURAL INSTITUTE'S PLACE IN MODERN INDIA

(INAUGURAL SPEECH, OCTOBER 28, 1953).

by

H. S. AZARIAH

The Institute is dedicated to the progress of agriculture and home life in rural India. Since independence there has been a noticeable emphasis in the country on agricultural progress and rural welfare. There is also a new eagerness to raise the standard of living of the rural masses so that the proverbial poverty, illiteracy, superstition, disease, and famine may be banished. We have chosen for ourselves a democratic form of government and plan to use democratic methods to achieve our goal. The plans for the future also continue to stress the urgency and importance of agriculture which is basic and vital to our national welfare. The Five Year Plan allocates slightly more than one-fourth of the entire expenditure to agriculture, irrigation works, and community projects. The pertinent question that naturally arises in ones mind is, "How far can we expect progress in the next five or ten years?" While one must admit that there are vast differences between the present atomic age and the past centuries, one may ask whether the experiences of the so-called advanced countries in the West can help us to estimate the progress that may be achieved? One needs only to read Charles Flint in "One Hundred Years of Progress in the United States" (1776-1876), or Orwin in "A History of English Farming" to realise how primitive western agriculture once had been. Cheap labor, primitive implements, unscientific cultural methods, and prejudice due to the isolated position in which these countries were placed characterised their agriculture. It is all too easy to forget that agriculture in Europe and in the United States was only a century and a half ago as primitive as in India today.

Three phases of agriculture are being stressed in India today : an *improvement in general agriculture* (which is geared to a well-defined food policy), a *better utilisation and management of land*, and a fuller *development of co-operation* which can help all of life in rural areas. Let us briefly examine progress in each of these three fields.

More than a century and a half ago, the East India Court of Directors sent twelve American planters, "to teach the people clean picking of cotton." No record is available to indicate whether the mission was successful! It took several famines and reports from three different Famine Commissions (1880, 1898 and 1901), to develop the agricultural departments and to introduce co-operation into the country. The Pusa Research Institute was founded two years later through the generous gift of the American, Henry Phipps. It took another 25 years for the government to establish the Indian Council of Agricultural Research to effect coordination between the Pusa Research Institute and the provincial agricultural departments. What have been the achievements? New strains and varieties of crops have been introduced, more fertilizers and manures have been distributed, and better implements have been developed. The

findings of the First Five-Year Plan with respect to agricultural production are interesting : "For *commercial* crops the data (over the last 40 years) revealed clear evidence of generally increasing yields, and in respect to sugarcane an expansion of area as well. In respect to *food crops*...yield trends are not uniform : yields show an increase for certain crops in certain States, a decline in certain others, and an absence of any perceptible change in the rest. Generally speaking, an expansion of area under a crop has been seen to be a factor associated with the lowering of yield." With an increase of 39% in the population during the last four decades, the available food grains from internal sources have shown an appreciable decrease per capita! And the lot of the farmer is much the same.

Equally interesting is the land policy. About a century ago, legislation was enacted to give fair rents to the people of the land. In this process, errors were made and discovered. A series of laws followed with the primary purpose of giving to the tiller of the land security of tenure and fair rents. Ejectment was made more and more difficult. The elimination of intermediary rights is the major achievement during the past few years. The idea behind these efforts seems to be a reflection of Arthur Young's slogan, that if complete ownership is given to the cultivator he will transform even a rock into a garden! Efforts have also been made to establish an economic holding and to set a limit on maximum holdings. Further there have been attempts to consolidate holdings so as to eliminate inefficiency and provide a workable unit. As the Congress Agrarian Reforms Committee pointed out, while consolidation is essential, that is no complete solution since there isn't enough land to go around. While it is too early to judge, the early indications are that mere ownership to a fair amount of land is not enough. The owner or operator needs enthusiasm, open-mindedness to learn new ways, and eagerness to improve his lot and to manage better his own affairs.

In the field of co-operation, nearly fifty years of progress is in the statistics! As you will recall, co-operation was introduced into the country as a palliative against famine. The first legislation was passed in 1904. On the credit side, we have now approximately 181,000 co-operative societies of various sorts with a membership of 14 million and a working capital of Rs. 276 crores. On the debit side, we have a structure without vitality and life, and societies depending too much on external help. The strength of the co-operatives, like the strength of a democracy, lies in its internal leadership. Too much spoon-feeding by the government will result in a bureaucratic co-operative! Co-operatives were born in Europe in an effort to be independent of the State : and even now the finest forms of agricultural co-operatives are to be found in Denmark where there is no legislation and no government red-tapism. For the success of co-operatives in our country, we have depended on government officials. This factor alone, the Five-Year Plan admits, is responsible, in a large measure, for the failure of a large number of co-operatives and the uneven development of the movement in the country.

Our progress so far then, is not spectacular. We have nothing to boast of. A study of the history of agriculture in the West, reveals that there were two vital decisions that these countries had to make : (1) with respect to land and, (2) with respect to our competitors – the animals. The standard of agriculture is superior in those countries where farmers are living on their farms. The pioneering and adventurous spirit, coupled with strong individualism, enabled the early settlers and subsequent

followers in the United States, to settle on their individual farm land. Denmark had to legislate to effect this. Whether people live on farms or in villages, their progress has always been associated with the availability of good roads, quick communications, and adequate police protection, which are all functions of the government. The second factor, namely the relationship of man to animals is of greater importance. Progress in agriculture was always rather slow, so long as animals roamed free. Not until they were put behind the fence, could the agriculturist see the effects of his toil and have an incentive to press forward. It is impracticable to require all farmers to fence their crops; it is easier to fence the animals. Stock laws or enclosure acts then, were basic to the progress of agriculture in the West. The losses due to stray domestic animals, parrots, monkeys, and other wild animals are colossal in our country. The present Cattle Trespass Act is ineffective. So long as legislators are elected by the people, they cannot dictate against the desires of the majority. This country must decide, sooner or later, whether man or animals must live. There is no room for both. The sooner the public conscience is aroused to this fact, the sooner will legislation be possible.

What then must be the role of the Allahabad Agricultural Institute? On the one hand, it should maintain a vital contact with the villager and on the other, it should help the country towards a sound national agricultural policy : and this could be done through its three-fold programme of extension, teaching and research. We have, at long last, been able to establish an extension programme which is well geared to the peasantry around us. From the experience of the Three-Year Extension Project, must emerge a sound well-balanced extension programme. We must maintain the gains and develop further in such a way, that the staff and students appreciate the difficulties of the farmer and render effective assistance in resolving them. This is vital to the life of the Institute, for this alone can make our teaching and research more realistic and fruitful.

In residential instruction, newer methods of effective teaching should be tried, allowing more time for students to get themselves acquainted with the literature in the subject and to do independent thinking. The whole of education must be such as to give the student a broad base so that we do not turn out mere agricultural technicians, but rather agricultural leaders, agricultural statesmen, and agriculturists, who are sensitive to agricultural problems and who can help in influencing the agricultural policy of the country, at the same time, expressing this policy in the language of the villager.

The backbone of effective work of this nature in extension and teaching is research : research, not in the sense of fundamental research, but rather scientific experimentation to find answers to the pressing problems of the farmer and his household. It is said that lack of research can make an ass of a teacher in twelve years! This is more applicable to an agricultural teacher in India. It shall be my endeavour to strengthen research in every department in the Institute. This will bring the teachers and the taught into direct contact with the real problems of the farmer, for without this, the purpose of this institution will remain unfulfilled.

We would be fighting a losing battle if the home were left untouched. The Institute was responsible for introducing in this state, home economics education at the Intermediate level. With the experience that has been

gained, it should be in a position to open two fronts : one to fight the squalor, ignorance, and disease that is attacking the rural woman and her family; and the other, to help the more fortunate city-sister, to help herself and to help the more needy in the villages. This is not an easy task. But we must press on.

To do effective work, the Institute need not branch out into new phases. Rather, the rapid expansion must be strengthened and gains made must be fortified. However, I will make an exception of one field, namely, rural sociology. To do the type of work I have mentioned, to understand the farmer, his cultural and social set-up, we need a sound division in rural sociology. This need must soon be met.

Above all, as long as the Institute bears the name of Christ, it should reflect the love of God for all men. The strength of the Institute in the past had been in its fine team work, and now by God's grace, there is even greater opportunity for witness to the work of the brotherhood that cuts across nationality and petty differences. May God give us all His grace to join hands in His love for the cause of the common man.

THE JAPANESE METHOD OF RICE CULTIVATION IN INDIA

By

K. RAMIAH,

Rice Expert with F. A. O., Bangkok, Thailand

Main Features of the Japanese Method : The main principles of rice cultivation as followed in Japan which produces the highest acre yields in Asia are well-known to the technical officers of the departments of agriculture in India but no active steps had until recently been taken to highlight them among rice growers as a special campaign beyond what was being done in regular extension work. What actually is the Japanese method of rice cultivation? The most important features associated with it are : (i) selection of good and heavy seed for sowing in the seedbed, (ii) sowing the nursery thinly, (iii) having seedbeds raised a few inches above the level of the field, (iv) manuring the seedbed adequately with both organics and inorganics, (v) removing the seedlings when ready with the least amount of damage to the roots and transplanting them in lines with adequate spacing, (vi) heavily manuring the fields with organics and inorganics, and (vii) frequent inter-culturing or stirring up of the soil in between the rows, 4 to 5 times when the crop is growing. The state governments have been consulted and thousands of charts and leaflets, suitably illustrated, have been prepared for distribution to rice farmers throughout the country. These leaflets written in all local languages describe the methods suitably modified according to the conditions obtaining in the different states. Arrangements have also been made to train workers, officials and non-officials, who will be in charge of the extension work connected with this campaign.

Relative Importance of the Several Features : Although all the points (i) to (vii) mentioned earlier together constitute the Japanese method there is no experimental data to determine the relative importance of the different factors contributing to increased yields. The Indian Council of Agricultural Research has suggested to all the state departments that they should carry out a suitable experiment in their research stations to obtain reliable information on the above point. But the figures of a simple experiment already carried out in Bombay State dealing only with some of the factors show clearly that the factor having the largest effect on yield was the fertiliing of the field. The contribution due to the manuring of the seedbed was very much less, hardly one third of the contribution by field manuring. The contribution due to inter-culturing was still less, about a third of the increase due to seedbed manuring. Even the small benefit accruing from the manuring of the seedbed may be limited to Bombay and not applicable to conditions in other states. This is from a rough preliminary experiment and more reliable information is bound to come from the better planned experiments that are being undertaken now in all states. There is, however, no doubt that fertilizing of the field is bound to be the most important contributing factor, and in advocating the Japanese method the greatest emphasis has to be placed on this. There is sufficient experimental data available already in different states with

regard to the optimum quantities of manures or fertilizers to be used for rice grown in them. So long as the dose recommended is kept within the maximum dose determined by experiments, it should be safe.

Seedbed : It has been mentioned already that the several features advocated with the Japanese method of rice cultivation are not all new. For example, sowing the seedbed thinly to get strong and sturdy seedlings for transplanting is a recognised improvement and has been advocated as an item of propaganda in Madras State for over 30 years. In important rice areas of that state this improved practice is already being followed. It is easy to adopt raised seedbeds when a dry nursery is raised. With regard to the wet nursery, the emphasis should be on long and narrow beds so that levelling can be made perfect resulting in satisfactory germination. With long and narrow beds with channels separating them, one cannot but have a slightly raised seedbed.

Selection of heavy seed for sowing by soaking the seed in salt water has been experimented with in different states. In genetically pure varieties developed from a pure line such selection is of value only in the case of early maturing rices, say 110 days and less, and not in varieties which take 160 days and more to mature. In the latter case it should be quite enough to eliminate light and half filled grains which float when the seed is soaked even in ordinary water. There may be no necessity of using salt water in this case. The main advantage in selecting heavier seed is that such heavy seed germinates quicker and the seedlings are uniform in size at the time of planting. Manuring of the seedbed is, however, important and emphasis should be more on the organics rather than the inorganics, so that with a thick layer of organic manure on the top, the pulling of seedlings will be easy and with little damage to the roots. Under Indian conditions, too heavy manuring of the seedbed may be even harmful, particularly when transplanting cannot be done at the stipulated time due to inefficient water control.

Spacing of Plants : In Japan the spacing to be adopted between lines and the number of seedlings to be planted per hole has been determined by regular experiments. The research results help them to determine the total number of plants to be planted per unit area, the number of plants to be planted per hole being adjusted to the minimum spacing to be allowed between lines to facilitate inter-culturing. Population density per unit area is an important factor determin g yield in cereals. In India also we have data to determine the spacing to be adopted in the fields, but this varies according to the varieties grown. While most Japanese varieties of rice take 135-150 days to reach maturity, we have in India much earlier and very much later varieties to grow. For any inter-culturing to be done without damage to the plants, 9 inches between lines will be the minimum distance. Adopting this spacing for both early and late varieties should mean a larger number of seedlings per hole for early-maturing varieties and fewer plants per hole for late-maturing varieties. Of the two factors involved, namely, spacing between lines and number of plants per hole, the former is more important and necessary adjustments will have to be made according to the maturity period of the variety. With 10″ spacing between lines 3 to 5 seedlings per hole for the varieties maturing in 120 days or less, and 1-3 seedlings per hole for late maturing varieties may be the optimum numbers.

Inter-culturing : Planting in lines and frequent inter-culturing are very special features of the Japanese method. Here emphasis has to be on inter-culturing and planting in lines facilitates the operation. Inter-cultivation as practised in Japan does not consist merely in removal of weeds but in stirring the soil between the plants to a few inches depth. In well-prepared wet rice, weeding is not a problem and a certain amount of weeding is usually done in India. Moreover, this stirring of the soil adopted in Japan goes with intensive manuring, and perhaps such stirring helps the plant to assimilate better the added nutrients. Stirring of the soil without adequate manuring may not do much good, and in fact, the results of the preliminary experiment conducted in Bombay confirm this view. The number of inter-culturings will depend upon the variety grown. It may not be possible or necessary to have more than two for an early variety while up to five may be desirable for a late variety. The last inter-culturing should be before the primordia are formed, *i. e.*, about two weeks before the short blade stage.

Manuring of the Field : Questions arise as to the quantity of the manure to be applied and the form in which it is to be applied. In Japan the very large quantities of manures applied to rice are partly in the organic and partly in the inorganic form, the latter containing the nutrients, N, P, and K. Because of the varying soil and climatic conditions obtaining in different parts of India, it is not advisable to follow a standardised schedule. Moreover, information is available, though on a limited scale mainly from experimental stations (Bihar State is an exception), on the optimum and maximum doses of fertilisers to be used. In Japan all organic wastes are scrupulously collected and made into compost and this forms the main source of organic manure. In India, the only organic manure available is cattle manure, but the quantity is limited. Fortunately, growing a green manure crop and turning it in is a practice that is slowly but surely extending and all available information points out that this is the best and the cheapest form of fertilizing rice fields. Available information points out that where 3 to 4 tons of green matter can be turned in, there is no necessity to supplement it with inorganics. There are, however, facilities needed to make the practice of green manuring a more general one, and in any case it cannot be practised universally. The only means of fertili ing rice fields is to apply the available small quantities of organics in the way of cattle dung, compost, and green manure and supplement them with chemical fertilizers. Each state has drawn up its schedule for fertilizing rice fields which contain both organics and inorganics. The inorganic source for nitrogen is universally ammonium sulphate and superphosphate supplies phosphorus. Some states like Bombay and West Bengal are recommending special mixtures where oil cakes and bone meal are added to the inorganics to replace part of the nitrogen and phosphorus requirements.

Nitrogen—the Chief Requirement : Nitrogen is the most important requirement of Indian soils and it has been found that 20 lbs. of N per acre is the minimum that can give a satisfactory response in most places. The optimum dose however, varies from 20 to 60 lbs. and it is even beyond 60 lbs. in a few areas like parts of Bombay. So long as the total nitrogen requirement cannot be met by green manure, the use of ammonium sulphate for rice has to become an established practice. It is not necessary at this stage to go into the question of the possible bad effects on the soil of a continuous application of ammonium sulphate. Acid soils where its

application is likely to be harmful are limited in extent. On most rice soils in India, with the limited quantities recommended supplemented by organics and phosphorus there is no necessity to be unduly apprehensive of such a bad effect. Research is going on and more fertilizer experiments under cultivators' conditions are being undertaken, and where a harmful effect is likely to result from the use of ammonium sulphate other forms of nitrogenous fertilizers can be considered. The use of more manure and commercial fertilizer is the most important factor connected with the Japanese method, and in India it should mean a greater use of ammonium sulphate for the present, and possibly a change over to other forms of nitrogenous fertilizers in the future where such a change is found necessary.

Method of Applying Fertilizer : The Japanese method of applying the fertilizers consists in applying all the phosphorus and potash and a portion of the nitrogen just before planting and the balance of nitrogen either in a single dose soon after planting or in split doses, one after planting and another much later, a few weeks before heading. Where the land is ploughed dry and then puddled and levelled, which is the practice in Japan, the initial application of the fertilizer is done when the soil is dry. The interval of time between this application and puddling for transplanting is never more than a few days, not more than a week. This might be followed in India too where dry ploughing of the soil is practiced. In areas where preparation of the land begins after letting in water the initial application of the fertilizer has to be at the time of planting, with a minimum amount of water in the field. With regard to single or split doses it may be useful to follow the information available from experiments. In the case of an early-maturing variety it may be safer to apply it in one dose soon after transplanting. Split doses may be considered only in the case of late-maturing varieties, and even here according to existing information it has not been found useful to postpone the last application six weeks beyond transplanting. Moreover, split doses may not be feasible where efficient water control does not exist.

Direct Sowing : The popularization of the so-called Japanese method should result in greater use of fertilizers in the country, and this happens to be the easiest way of stepping up acre yields. It has to be understood that the Japanese method can be introduced only in areas where raising of seedbed and transplanting the crop is regularly practised, and where reasonable water facilities exist. Rice is also grown as a pure rainfed upland crop in Japan. Here the crop is sown in lines, nearly a foot apart, and the space between is frequently inter-cultured and the soil earthed up on either side. Manures and fertilizers are applied at the base of the plant before earthing up. This practice is capable of being followed in parts of India where rice is generally broadcast just before the break of the southwest monsoon. Recently even for transplanted rice, Japan has been experimenting with sowing the seed directly in lines and the results are said to be extremely satisfactory. The yields have been found to be as good as and even better than from a transplanted crop, and the additional advantages are the saving in labor and water use There is no doubt there is scope for undertaking such experiments in parts of India.

Improved Varieties and the Japanese Method : In the Japanese method, fertilizing the field and growing an improved variety of rice are inter-dependent. According to the Japanese, improved varieties

do well only when intensively fertilized, and the best returns are obtainable from the use of fertilizers only when improved varieties are grown. Suitable improved varieties are available to meet he requirements of different rice areas of Japan and the determination of varietal response to fertilizers is an integral part of breeding research. This question has perhaps not received much attention in India. The maximum yield of grain under ordinary methods of rice cultivation as generally followed has been the main objective in breeding. It has been found, however, in most places that the improved varieties have done very well with intensive manuring. In Japan there is a good organization to multiply and spread improved varieties, and in fact, Japan is the only country in Asia which has the larger part of the rice area, about 70 per cent, covered by improved varieties. In India the intensity of breeding and evolution of suitable varieties for different areas varies among different states, and it may be said that states like Madras, Bombay, and Madhya Pradesh do have a range of varieties to suit most of the requirements. The total area under improved varieties is not, however, impressive although according to information available with technical officers, the area as given in official statistics is a gross underestimate. The area given in statistics has been calculated mainly on the basis of the quantity of seed handled and distributed by the department whereas there is an appreciable amount of spread taking place among cultivators themselves. Moreover, there has been no satisfactory attempt made to determine the area under improved varieties which under conditions obtaining in India, a rice deficit country, is beset with special difficulties. Perhaps collecting information on varieties along with random sampling for estimating yield could give a more reliable picture about the spread of improved varieties.

There should not be any difficulty in following the Japanese method in states which have already a range of improved varieties suited to different needs but in others where either suitable varieties for different areas are not available or the suitability of the existing varieties to such areas has not been determined the matter needs immediate attention There is no doubt that the successful spread of the Japanese method should stimulate more intensive work in breeding to obtain varieties that will stand up to intensive manuring.

Implements Connected with the Japanese Method : Fortunately the taking up of the Japanese method does not involve any outlay on special implements. Planting the seedlings in lines can be done by stretching a marked string across the field from bund to bund and shifting it after planting each line. This should be an easy operation where fields are small, about half an acre or less. It may be a problem in areas where the fields are large as in the flat river deltas. In Japan and Formosa where rice is always planted in lines, there is a special improvised implement, a revolving drum made of cheap and light wood or even split bamboo which can be dragged along the field after it is properly levelled and where water has been drained off, and it leaves marks in the soft mud in a chessboard fashion. Seedlings are planted where two lines intersect. Attempts are being made to design such an implement also in India. With regard to inter-cu'turing or stirring of the soil in Japan, there are special rotary weeders in use. Often a few of these of different sizes form essentia' equipment for every rice farmer. The rotary weeders have been imported and tested in India, and they appear to be satisfactory. They are, however

somewhat expensive. One of the agricultural machinery manufacturing firms in Calcutta has turned out a weeder which is quite as efficient as the Japanese one. It costs Rs. 20/- each, and already a small demand has developed. In Bombay and Madras the departments have designed a special hand hoe with curved teeth which somewhat answers the purpose, although they cannot be as efficient as the Japanese weeder. However, they cost only a rupee or less each.

Economics of the Japanese Method : The Japanese method of rice cultivation does involve an appreciable amount of hard labor and attention to details, much more than the general Indian rice farmer is accustomed to. A question is often asked whether the Japanese method of rice cultivation is economical and whether the economics of the method have been determined for Indian conditions. In Japan, as in parts of India, the size of the holding is extremely small and the rice farmer has to put in unremitting and incessant labour to get the maximum possible out of the land so that he can make a decent living out of it. All members of the family including children work in the field and the question of economics, *i. e.*, calculating in money value every bit of work which the farmer or members of the family put into the field, does not arise. In fact, in Japan there is very little outside labor actually hired for the field work. Where necessary the farmers help each other in operations like transplanting or harvesting. In India also the taking up of the Japanese method must involve more work on the part of the rice farmer. It will not, however, be justifiable to calculate the money value of every bit of field work as if he engaged labour for every field operation and paid for it. If this is done, it may perhaps not prove highly economical. In Bombay the special leaflet does show the economics of the Japanese method and it appears to be highly profitable. There will, of course, be more labour involved in the preparation of seedbeds, weeding of the seedbeds, transplanting seedlings in lines, and frequent inter-cultivation later. How far the farmer himself can contribute to this additional work or will be obliged to hire labour will depend upon circumstances of the individual, but in any case, it has to be understood that the Japanese method is essentially a method suitable for small holdings and where the farmer himself is expected to contribute most of the labour involved. It follows also that there must exist sufficient facilities or incentives to encourage the farmer to put in more work in the field.

Facilities and Incentives : While so far the technical aspects of the Japanese method have been discussed, there are certain facilities which the rice farmer in Japan has and which the Indian rice farmer has to be given to make the campaign an unqualified success. Principally these facilities are (1) making the fertilizers available to him as near to his door as possible and (2) providing credit facilities for him to purchase his fertiliser requirements. The former is perhaps not receiving as much attention as it should. The main requirement is the opening of a large number of depots in the interior of the country so that at no place the farmer has to travel more than five miles to get his requirements. Taking Madras State, the largest user of fertilizer in India, in two districts, East and West Godavari, where people have been using fertilisers, there is only one depot available at each taluq headquarters, about 13 in all for the two districts. While farmers accustomed to use fertiliser continue to do it, the practice has not spread to neighboring areas where practically identical conditions exist. The opening of more depots and arranging for demonstrations in new areas could easily double the consumption of the fertilizers. Expenditure on these items should be only a fraction of the cost involved in the whole cam-

paign, and it should be quite worth undertaking. While it may not be possible to develop an extension service in India on the scale available in Japan, at least a small strengthening of the service is necessary if the campaign is to prove an unqualified success. How soon the working of the community projects and training non-official personnel will effectively help extension work remains to be seen.

The departments of agriculture are fully alive to the problem of increasing the number of depots where seed and fertilizers can be made available to rice farmers but the main difficulty appears to be finance. Any extension of the existing facilities could have the maximum effect in Madras State where the farmers are already fertilizer-minded, much more than in other states. With regard to credit facilities, all state governments have arranged to grant loans of fertilizers to rice farmers.

For the present, the supply of fertilizer at reasonable cost and making it easily available on credit would be sufficient incentives. There is, of course, the price of the produce which is, however, controlled, though there may be variations in this from state to state. With an average price of Rs. 10/- per maund (82 lb.) of paddy and Rs. 400/- for a ton of amonium sulphate, the application of 100 lb. of ammonium sulphate costing Rs. 17/- can be expected to bring an additional yield of 3-3½ mds. of paddy which means a profit of Rs. 13/- to 18/- per acre. With a lower price for paddy or a higher price for the fertilizer the profit will of course be less. Until recently, ammonium sulphate was being sold at Rs. 350/- a ton, and including transport and incidental charges was costing actually about Rs. 400/- to the cultivators in most places. In Madras the fertilizer was actually costing the farmers more than Rs. 450/-. To encourage the use of the fertiliser and to give an incentive to the Japanese method, the Central Government which controls the production, import, and distribution of the fertilizers has now reduced the price to Rs. 290/ a ton which is a great incentive. This means that the farmer will not have to pay more than about Rs. 350/- per ton at his door. Whether further incentives will be required can perhaps be decided as the programme progresses.

CROP STATISTICS IN INDIA

By

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Statistics of agricultural production in India are based on judgement forecastes and estimates derived from observations and, also, from the actual cutting and weighing of sample areas, that have been selected at random. Crops are classified into three groups for reporting purposes as follows:

1. Rice, wheat, sugarcane, cotton, jute, linseed, rape, mustard, sesamum, castorseed, and groundnut.
2. Barley, *juar*, maize, gram, tobacco, and indigo.
3. Tea, coffee, and rubber.

All-India Forecasts : For crops in the first group, an All-India forecast is issued periodically. For instance, for wheat there are 5 forecasts per year; for cotton there are 4 regular forecasts and a supplementary forecast; for sesamum 3 and a supplementary one; for rice, sugarcane, groundnuts, linseed, rape, and mustard 3 forecasts each: for jute 2 fo ecasts and for castorseed one forecast. The forecasts for jute are prepared by the Director of Agriculture, West Bengal. The others are made by the Ministry of Agriculture, (India).

The first forecast provides early information about the size of the area sown. Intervening forecasts give an account of later sowings, the condition of the growing crops and an estimate of the probable yield. The last report supplies the figures on total area in the various crops and the estimate of yield. Supplementary forecasts are made to supply information on crop area and yield that was not available at the time the last regular report was assembled.

The condition of the crop and its probable yield in foreign countries is included in each forecast report.

Crop forecasts are carried in the Indian Trade Journal, published by the Ministry of Food and Agriculture. Information on crop conditions in other states as well as data on the temperature, humidity, and rainfall are also published regularly by the Government. Final estimates of the area under the different crops and the yield produced by these crops are contained in the annual publication titled, "Estimates of Area and Yield of Principle Crops in India."

Estimates of total production are obtained by multiplying the estimated area in acres by the estimated average annual yield per acre. The estimated average yield per acre is itself determined by multiplying the *standard normal yield* by what is called the *condition factor* for the season. The accuracy of the estimates, therefore, depends upon the accuracy of the

reported figures for

(a) Area under the crop

(b) Standard normal yield per acre, and the

(c) Condition factor.

Various methods are used in making crop estimates. They are influenced by state conditions, availability of resources, and the climatic adaptation of the crops. But the chief aim of all of them is to estimate the average yield per acre and the total production of crops in individual districts, in states, and in the nation as a whole.

A brief resume of one of the methods used is being presented to serve as an illustration. The one chosen is characterized by simplicity and may be described as a *crop cutting experiment by multistage sampling.* It follows approved statistical procedure in the selection of sample areas at random. The state constitutes the unit and the districts chosen to represent the state are determined by a random sampling method. Within districts, taluqas and villages are also chosen at random as well as the location of the individual plots that are to be harvested for yield determination. Driage of the particular plot is also taken into consideration. When the plot has been located an area 33 feet by 33 feet is taken and the crop cut. From these selected plots the standard normal yield per acre is estimated. This method is followed chiefly in Bombay and Madras States. Other states make use of this method to some extent, except Delhi State which does not use it at all. The figures received from the various states are consolidated and published in the "*Quinenquennial Report on the Average Yield per Acre of Principal Crops in India.*"

The first factor involved in estimating crop production; namely, the *area under the crop* can conveniently be secured from village records. The second factor, the *standard normal yield per acre* is determined by harvesting random samples as described above or by observational estimates of crop reports. The third element entering into the estimates is the *condition factor* by which is meant the condition of the crop in a particular season compared with a so-called *normal season condition.* The normal season condition is arrived at by averaging *annewari* estimates reported by village accountants over a period of years. These *annewari* estimates are not perfect. They have a strong downward bias; therefore, the condition factor is usually an underestimate of the true condition.

From the indefinite character of the three factors entering into the estimation of yield, the final estimates are manifestly not entirely accurate.

The area and yield estimates of the crops in the second group; namely, barley, *juar*, maize, gram, tobacco, and indigo, are obtained from seasonal crop reports of the states, and where available, from local authorities, too. The consolidated figures are given in the annual publication; "Estimation of Area and Yield of Principal Crops in India." These data are admittedly incomplete and as All-India figures they are only rough estimates.

Special annual publications are devoted to each of the crops in the third group, namely, tea, coffee, and rubber. Figures on the area under the crop and average numbers of persons employed daily on the plantations, together with data on exports, imports, consumption, and stocks are also included.

OCCURRENCE OF *PIRICULARIA ORYZAE* ON SOME GRASSES OF THE ALLAHABAD AGRICULTURAL INSTITUTE FARM

By

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Paddy blast, one of the most serious diseases of paddy, is caused by a fungus known as *Piricularia oryzae* Cav. The disease appears first on the leaves in the form of spindle-shaped dark brown spots with greyish central regions. At the time of flowering the fungus infects the base of the peduncle (stalk of the inflorescence) and completely cuts off the food supply to the developing ear, as a result of which the grains fail to develop. In the month of August while the authors were engaged in the survey of weeds on the farm, the characteristic spindle-shaped greyish spots caused by *Piricularia oryzae* Cav. were observed on the leaf blades of various grasses aside from paddy (*Oryza sativa*, Linn.) and Italian millet (*Setaria italica* Beauv.) Recently reports of the leaf spots caused by *Piricularia* on grasses other than paddy have been made by some workers. In India, Thomas [2, 3] observed the diseases on *Eleusine coracana* Gaertn. (*ragi*), *Digitaria marginata*, *Setaria italica* and *Panicum repens* N.L. Burm.; while Anstead[1] reported it on *Brachiaria ramosa* Stapf. (*chapar*) and *Paspalum sanguinale* Lamk. (*takri*). Aside from hosts recorded by previous workers the authors have collected from the Agricultural Institute farm two more grasses *viz.*, *Eleusine indica* Gaertn. (*jhingri*) and *Dactyloctenium aegypticum* Richt. (*makra*) which were found to have *Piricularia* spots on the leaf blades.

Infected leaves of paddy, Italian millet, *makra*, *jhingri* and *chapar* were incubated in a humid chamber to encourage spore formation of the fungus to find out whether the fungus occuring on the above mentioned hosts would show any morphological differences. The measurements of the spores of the fungus from the different hosts were made after an incubation period of four days by which time profuse sporulation had taken place. The observations recorded (Table I.) indicate that the variations in shape and size of the spores are not wide and that the spore measurement fall within the range given for *Piricularia* (14-40μ x 6-13μ).

TABLE I.

SPORE MEASUREMENTS OF *PIRICULARIA ORYZAE*

Hosts	**Range in μ**	**Mean (of 50 spores) in μ**
Paddy	15.8-24 x 5.3-9	23.2 x 8.2
Takri	18-27 x 7.2-9.8	23.3 x 8.3
Chapar	15-30 x 6-9	23.0 x 7.0
Jhingri	15-28 x 6.5-9.5	24.4 x 8.4
Kodon (Italian Millet)	22-30 x 7.5-9.8	25.6 x 8.6

Attempts to isolate the organism from the various hosts were met with failure except in the case of *chapar* (*B. ramosa*). The first single-spore transfer into potato dextrose agar developed spores within a fortnight. In the subsequent subcultures the spore development failed to take place, and the rate of growth of the fungus was extremely poor. However, where the isolate was grown in maize-plant-extract-agar, growth was much faster (25 m. m. in 4 days) than in potato dextrose agar (3 m. m. in 4 days). Maize extract agar did not promote spore production although it accelerated the mycelial growth. A suspension of the spores of the isolate from *B. ramosa* in sterilised tap water was sprayed with the aid of an atomiser on the following hosts grown in pots : *takri chapar, makra, jhingri* and paddy. The first four hosts were in flower while the last was in the seedling stage (a week old). Final observations were recorded four weeks after spraying. Paddy failed to take infection although the four other grasses developed the disease. The characteristic spots of the disease appeared on all hosts with the exception of *chapar*, where infection was observed at the nodes in the form of water-soaked brown discoloration. The branches were found to break at the nodes which were severely infected. It is sufficiently clear therefore, that the isolate from *chapar* is incapable of infecting paddy, although the spore measurements and shape are not different from those of the paddy isolate. It is hoped that inter-inoculation experiments which are now under way with the isolates of *Piricularia* from various graminaceous hosts on the farm will indubitably throw some light on the part played by various susceptible grasses in the incidence and spread of paddy blast.

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NEXT ISSUE

Dr. G. H. Dungan, leading agronomist from America tells how *hybrid maize* can perform miracles for India.

MOULDBOARD AND DISC PLOUGHS*

The plough is among the earliest types of tillage implements invented to be drawn by animal power. Wooden sticks tied or spiked together, or tree forks were used first; later a metal point was added. These types of ploughs were in use centuries B. C. It was not until the eighteenth century A. D. that the single-furrow plough, as we know it today, was evolved.

Modern ploughs are lighter and stronger as a result of the use of improved materials. Also, they range from a single furrow to eight and ten furrows. The larger types are mostly found in wheat-growing areas.

Of late years various means have been evolved to couple the plough directly to the tractor, by the use of either mechanically or hydraulically controlled attachments.

To get useful and long life out of a plough, it is essential to keep it in good order. All nuts and bolts should be checked for tightness at fairly frequent intervals, because a loose or lost bolt places extra strain on other sections, causing them to get out of alignment or break.

The Mouldboard Plough : The mouldboard plough is designed to cut and lift the soil, turn it over and bury the surface growth. If it is to do this efficiently the mouldboard plough must have :

Sharp and correctly set shares;

A level plough frame;

A correctly adjusted hitch.

Ploughing speed best suited to the conditions.

The main components of a mouldboard plough, their settings and maintenance, are outlined below.

The Frame : The frame of a multiple-furrow plough should be level both vertically and laterally. If each foot (bottom) is to plough at an equal depth and width the frame members to which the feet are attached should run parallel to the line of draught and be an equal distance apart. Twisted frame members cause an excessive strain on the plough, increasing the draught and the tractor fuel consumption.

The Foot : The foot (bottom) of a plough should be perfectly upright, and run true to the direction of travel – the exception being the front foot on a multiple-furrow plough. The front foot of the Australian-type stump-jump plough is turned 3/4 in. to the landside to steady and hold the plough in the furrow.

The Share : Side suction is given to a share to make it cut its proper width and to hold the plough in the furrow. Bottom suction is given to a share to aid penetration. The amount of side suction is approximately $\frac{1}{4}$ in. that is, the point of the share is 1/4 in. to the landside of the body of the

*Issued by Australian Government Trade Information Service.

share. To check the side suction of a share, place a straight edge alongside the foot with the edge touching the share point and the heel of the landside; at the point where the share and the landside join, clearance between the straight edge and the share should be 1/4 in.

The amount of bottom suction varies between 3/8 in. and 1/2 in. according to the type of plough and the hardness of soil being ploughed. Bottom suction can be checked by placing the straight edge along the bottom of the foot with the edge touching the share point and the landside heel. The maximum clearance should be where the share and the landside join. The usual bottom suction on garden type single-furrow ploughs is 3/8 in., on the larger type of plough it is 1/3 in.

Some types of plough shares are given their bottom suction by bending the share point down after sharpening; some by tilting the share forward by a justing the foot, and others by shaping the frog or foot of the plough.

It is a good idea to check the shares when they are new and then when they have to be resharpened, the method adopted to give them suction will be known. Never bend down the point of a share which depends on the shaping of a frog or foot to give it suction; this additional suction would give the plough a tendency to bury itself, thus increasing the draught unnecessarily and leaving a ridgy bottom on the furrow.

Plough shares should be kept sharp – blunt shares do poor work and require more power and fuel to draw the plough along. It costs more in fuel to plough with worn and blunt shares than it does to have the shares re-sharpened. It is a good plan to have two sets of shares on hand so that when one set is being sharpened there is no delay in ploughing.

The Coulter : The purpose of a coulter is to help penetration by cutting the hard soil surface, grass roots and other surface covering, and to prevent the surface trash packing around the plough foot. For normal conditions the lower portion of the coulter should be 1 1/2 in. above the share point. In hard conditions, or in deep ploughing, the coulter should be raised and moved to the rear towards the shin of the foot, as otherwise it will tend to raise the plough out of the ground. To obtain clean straight furrow walls when ploughing in soft or crumbly conditions, set the coulter approximately 1/2 in. out to the landside of the share.

The coulter should not cut any deeper than 4 in. To lessen the draught and prevent excess wear, a rolling coulter should be kept oiled.

The Mouldboard : The mouldboard's chief functions are to turn the soil over and bury the surface growth, at the same time exposing the grass roots to the air so that they will die.

Mouldboards and shares should never be allowed to become rusty. Rusty mouldboards will not turn the sod cleanly; they tend to cake up and increase the draught considerably. It can be seen from this that apart from poor ploughing, rusty mouldboards increase the tractor fuel consumption and the cost of operation.

Designers have evolved types of mouldboards to cope with various types of soil and conditions. The main types of mouldboards can be described as short, general-purpose or medium, long, and skeleton.

Short boards are used to break up the sod or stubble and are used mainly with wide shares. Long boards are used to turn the sod flat and are used chiefly in heavy soils. Less side draught is imposed on a long board than on a short board. Skeleton boards are used in sticky clay conditions.

When not in use mouldboards should be cleaned, and coated with oil or some other rust-resisting compound.

Wheels : Wheels are fitted to ploughs for three purposes – to transport the plough, to control ploughing depth and to hold the plough in the furrow. The front furrow wheel should be in the furrow and about $1\frac{1}{2}$ in. to 2 in. in from the furrow wall. With the wheel in this position the plough is not so likely to come out of the furrow if the tractor is allowed to wander slightly.

In sticky soil the wheels tend to cake up; this alters the ploughing depth as the caked mud increases the diameter of the wheel. Altering the depth by means of the levers to compensate for this condition is not a good practice, as the wheels generally tend to build up unevenly. It is far better to fit wheel scrapers.

The rear wheels on a plough should have a slight lead towards the furrow to help counter the side draught.

A plough wheel works under a heavy load and at times under dusty conditions, and is subject to a constant side thrust. To prevent excessive wear, wheels should be oiled every four hours. Where grease cups are provided they should be checked every four hours.

The Handles : Walking-type ploughs are fitted with handles, which should be adjustable to suit the height and convenience of the operator.

The Levers : The levers on a plough are for regulating ploughing depth. They should work freely and be placed in such a position that the operator can quickly alter the depth to cope with varying soil conditions, or when turning corners. If levers are not in a convenient position or are hard to operate, they are usually not used and poor ploughing results. To prevent excessive strain being placed on foot and frame, it is a good practice to raise the plough when turning a corner.

Hitch : The position of the hitch is important. Under normal conditions on a multiple-furrow plough the position of the hitch is about 2 in. to the right of the centre of width of cut. The hitch in this position helps to overcome side draught on the mouldboards. In hard soil the hitch may have to be moved even further to the right, whilst in sandy or loose soil, or when ploughing at a shallow depth, the hitch may have to be moved to the left of the centre line of draught. (To determine the left and right sides of a plough, stand behind the plough and face the direction of travel).

The vertical position of the hitch is as important as the lateral position. To find the vertical position of a hitch is simple if the following method is followed : Back the tractor up to the front of the plough and position it in the centre of the line of draught; draw an imaginary line between the tractor drawbar and the highest point of the share nearest the

centre of the width of cut; locate the hitch on the plough where this line crosses the vertical hitch on the plough. A hitch should always lead upwards to the tractor drawbar. If the hitch is too high on the plough, the front wheels carry too much weight and the wheel bearings will quickly wear out; also poor ploughing will result because the downwards pull on the plough by the tractor raises the rear of the plough, upsetting the angle of the share and mouldboard in relation to the furrow. This also increases the draught.

Too low a hitch has the effect of lifting the plough out of the ground.

Disc Implements : For hard soil conditions a disc plough is often preferred, particularly when handling heavy weed or brush growth. Disc ploughs can be divided into three types – stump-jump disc plough, set disc plough, and disc cultivating plough.

The stump-jump disc plough is the best in incompletely cleared country as the spring attached to the arms carrying the discs allows the discs to ride over obstructions.

The set disc plough is a most useful implement on cleared land.

The disc cultivating plough is the one most commonly used in the wheat growing areas, because its lightness of draught enables a greater width of cut to be obtained, although it has not the penetrating qualities of the disc plough.

Discs : Discs are made in various sizes and have a varying amount of concavity to suit different soil conditions and for different types of implements. The deeper the disc, the greater its penetrating and soil turning qualities. When purchasing discs it is wise in nearly all cases to purchase the largest size for the particular implement. The shallower type of disc is used for implements such as disc harrows, where penetrating power is not required to the same extent as with a disc plough. Having the discs about 1 in. shallower in front helps to keep an even depth across the width of cut. The front discs have a tendency to dig in deeper than the rear, because the pull exerted has a tendency to raise the rear of the plough. The larger disc permits the maximum amount of clearance between soil and underframe and also keeps the disc bearing as far away from the soil as possible.

Hitching : A disc cultivating plough is rather difficult to keep in the furrow if the hitching of the plough to the tractor is not understood. The centre of the width of cut is nearly always the line of draught on a disc plough. However, in hard soil the draught line will move to the right, therefore the hitch will have to be adjusted accordingly. Imagine the centre of the plough as a pivot point – the weight of a tractor or team is too great for the disc to roll the front of the plough very far out of the furrow; the weight is not so great at the rear of the plough, and this enables the discs to turn the plough out of the furrow. This action is often called "crabbing". There are two ways to overcome it – firstly, "position" the hitch to the offside of the centre of draught, and, secondly, turn the rear wheels slightly towards the furrow.

Ploughing with the Disc Plough

Breastcut and Undercut: The discs on a disc plough are set at an angle to the direction of travel and the bottom of the disc has a lead forward. The angle of the disc is called breastcut and the lead is called under-

cut. Undercut is given to the discs for penetration purposes and to leave a level furrow bottom. Too much undercut on a disc hinders penetration. Breastcut helps the disc to penetrate and turn the soil – the harder the soil the more breastcut is required.

Maintenance : To get the best penetration the discs should be kept sharp. Discs should be replaced before they wear to such an extent that the disc bearings drag in the soil.

Severe strain and stress is placed on disc bearings and wheel boxes, and frequent oiling and checking of bolts and nuts is necessary.

Disc bearings should not have a great amount of end play. They are assembled with removable shims to take up the end play.

It is not advisable to turn a disc plough sharply to the right. To do so causes excessive strain on the discs and bearings and severe damage could result if an obstruction were met. When turning to the left discs straighten and turn, like wheels, and can do no damage.

A disc plough should never be worked unless the disc bearings turn freely. A flat side will soon wear if the disc is not turning.

The Disc Harrow : Disc harrows are useful for working fallow land covered with a dense growth of trash, weeds etc.

Disc harrows should not be angled more than is required to do an efficient job. Too much angle has a tendency to make too fine a tilth. On land infested by vines little or no angle should be applied so that the discs may cut the vines.

Tandom disc harrows should track – that is the rear discs should run between the tracks of the front discs. The nut on the disc axles should be kept tight. If the nut is allowed to work loose, the discs will turn or move on the axle and ruin it.

SHORT COURSE IN CAFETERIA AND INSTITUTIONAL MANAGEMENT

By

MISS FLORENCE KIMMELSHUE

The old saying "the proof of the pudding is in the eating" was borne out on Tuesday, October 20, when 9 men and 7 women received certificates for the completion of a two-weeks short course in Cafeteria and Institutional Management given by the Home Economics Department of the Allahabad Agricultural Institute. The 16 men and women, all except two of whom were managers of restaurants, hotels, and hostels in Allahabad, prepared the luncheon which was served to the members of the Institute Council, the teachers of the course, and other guests. All reported a most excellent meal. At the luncheon the purpose of the course was explained by Miss Florence Kimmelshue, head of the Home Economics Department, and short addresses were given by Dr. A. T. Mosher, former Principal of the Institute and Prof. A. C. Banerji, Vice-Chancellor of Allahabad University. Mr. Sampat Roy, proprietor of Rama's restaurant, Allahabad, replied on behalf of the class.

The two-weeks' course included classes in health and sanitation, selection and care of equipment, meal planning and meal peparation, food likes and dislikes, selection of water heaters and stoves and refrigerators and cold storage rooms, sewage disposal and plumbing, food preservation, management of the kitchen and dining room and system and system of checking, and money management and accounting.

The members of the class used the Institute Cafeteria as a laboratory where they prepared various dishes as part of the regular cafeteria meals.

First hand information was gained in two field trips in Allahabad. On the first trip, the students visited some of the prominent restaurants in Allahabad including the Sind-Bombay Hotel, Rama's Restaurant, India Coffee House, Royal Hotel, G. A. Kellner & Co., Eshwardas and Sons, and the Annapoorna Cafeteria. The second trip included an early morning tour of the markets in Allahabad, followed by a tour of establishments where equipment is made and sold.

GREEN MANURING*

Green manuring is one of the easier ways of increasing the fertility of the soil. To do this, sow a leguminous crop, and at a certain stage of its growth, plough it under. It decomposes and becomes mixed with the soil, restoring the soil's nutritive properties which are essential for the proper growth of any plant.

If any leguminous plant is uprooted, small nodules will be visible on the roots. These nodules contain bacteria which have the property of fixing atmospheric nitrogen and releasing it for the use of the plant. Of the many things which plants require for their growth and which they extract from the soil, nitrogen is the most important.

Agricultural scientists tell us that :

(a) Grain of wheat contains 1.93%, and the chaff .53% of nitrogen
(b) ,, ,, paddy ,, 1.08% ,, ,, ,, .68% ,, ,,
(c) ,, ,, barley ,, 1.66% ,, ,, ,, .68% ,, ,,
(d) ,, ,, *jowar* ,, 1.66% ,, ,, ,, .50% ,, ,,

It is thus easy to understand that many hundreds of maunds of nitrogen are used up in a field where wheat, paddy, barley, or *jowar* is grown. The soil remains impoverished if the nitrogen which has been removed by cropping is not put back into it. It is in order that the soil may regain its original richness and fertility that green manuring is necessary.

The advantages of green manuring may be thus summarised :

(a) It promotes the growth of beneficial soil bacteria.
(2) It increases the supply of nitrates in the soil.
(3) It helps retain moisture in the soil.
(4) It renders hard clay soils suitable for crops by improving the soil tilth.
(5) It improves the physical structure of the soil nd thus assists in draining excess water from the soil.
(6) It discourages the growth of weeds by enabling the crop to compete with them.
(7) It reduces soil erosion by increasing the absorptive power of the soil and thus reducing water run-off.
(8) The roots of the plants used penetrate the soil deeply and open up tight subsoils.

Crops most suitable for green manuring should be capable of rapid growth and quick decomposition. They should have tender stems and abundant foliage. Such a crop should be capable of being raised inexpensively, and on poor soil.

*Adopted from a pamphlet in Hindi writers by Mr. Guru Din Singh, Farm Manager and Mr. H. C. Joshi of the Extension Project, Allahabad Agricultured Institute, published by the Extension Project.

Experience shows that the crops most suitable for the purpose of green manuring are sann hemp, indigo, *d aincha*, *guar*, *senji* and Moong No. 1. These are capable of supplying 30 or more seers of nitrogen per acre, and about 300 maunds of vegetable matter.

If it is intended to provide green manuring for the winter crop, the seed should be sown immediately after the first rains in the preceding monsoon season. Where irrigation is possible, the seed may be sown a little earlier, so that the crop may attain greater growth before it is ploughed under. Conversely, if the green manure is meant for the monsoon crops, the seed should be sown in winter, but this is possible only where facilities for irrigation exist.

The right time to plough under the green manure crop is when the plants are just about to flower; but it should also be borne in mind that a couple of showers of rain are essential after the crop has been ploughed under, to assist the process of decomposition. The standing crop should be planked down before ploughing. When the plants lie parallel to the direction of the plough the green manure will be more completely buried by the soil turning plough than it will be if the plants are erect. It may be advisable to plough the area a number of times, so that the decayed vegetation may become thoroughly mixed with soil. This usually takes from four to five weeks.

The advantages of green manuring are gradually being appreciated, particularly in Mahewa Circle in Etawah District, U. P. where this method of restoring soil fertility is practised widely. Farmers are of the opinion that crop yields are much better when green manure is used than when chemical nitrogen is used. A survey showed that with green manuring the yield of wheat per acre was 35 maunds, 20 seers, and 6 chattaks, whereas with the use of ammonium sulphate the yield was only 29 maunds, 29 seers and 5 chattaks.

Green manuring is the least expensive of all methods of nitrogenous fertilization. Farmers are, therefore, using this type of manuring increasingly. Reports from different parts of the country indicate very convincingly that the application of green manure definitely increases yields. The use of sann hemp for green manuring increased the yield of paddy by 45% in Bombay, by 69% in Madhya Pradesh, and by 100% in Madras State. Sann hemp, cowpea and *dhaincha* increased the yield of paddy in Bengal by 14 1/2%, while with the use of sann hemp in Uttar Pradesh, the yield went up 68 1/2%.

Green manure has an equally beneficial effect on the wheat crop. The application of sann hemp or *bhang* boosted the wheat crop by 35% in the Punjab; an increase of 45% was obtained in Uttar Pradesh. In the same area *dhaincha* used as green manure gave a 16% yield increase. The best results came from Bihar where sann hemp shot the yield up to 106% over normal.

DRY-WEATHER PLOUGHING*

Ploughing may be done at three different periods, according to the season. The first, with which every farmer is familiar, begins with the onset of the monsoon and continues until all the land has been worked. The second begins when the rains have ended and continues until the *rabi* crops are seeded. This period coincides roughly with the month of October. Ploughing at this time is an accepted practice with the cultivators. The third period for ploughing starts when the monsoon crops have been harvested and stretches through the cool season up to the beginning of the monsoon rains the next year. It extends from December to mid-June. This is called dry-weather or dry-season ploughing. The purpose of this paper is to set forth the advantages of ploughing during the dry season and to describe how this operation can be most easily accomplished.

Promptness is important in dry-weather ploughing. After *jowar* and *bajra* have been harvested, plough the land as soon as possible. If this cannot be done, the drying of the exposed soil results in the formation of a surface crust which is thin at first, but which penetrates more deeply the longer ploughing is delayed. Therefore, plough the fields before the heat of the summer season sets in. If this can be done, ploughing will be easy. The bullocks will not have to labour hard, nor will the plough wear very much. Also, ploughing at this time will turn under grass, weeds, and other vegetation growing or lying on the surface while they are in a fairly succulent condition. This will facilitate the conversion of these materials into useful manure.

The *rabi* crop is generally harvested towards the end of February and during the month of March. Use special care to plough the fields after this harvest before the soil dries out. So long as the *rabi* crop occupies the field, even though the plants become dry before harvest, the direct rays of the sun do not reach the soil. Some moisture, therefore, is retained by the soil and this is usually enough to make ploughing easy, even though it be a dry season. If the fields are ploughed as soon as the wheat, barley, gram, and peas have been harvested, the operation can be easily done with an average pair of bullocks and a steel plough. The stubble of the previous crop will be ploughed under and be converted into manure for the use of future crops.

Here again, ploughing should be done immediately after harvesting the crop. This is so important it is recommended that the ploughing be started the morning of the day following the evening when a field is harvested, or in the afternoon after the crop was harvested in the morning.

If for any reason, the ploughing of these harvested fields is delayed, it will be difficult to plough them later with an average pair of bullocks, as the soil is apt to dry very quickly. After the earth has hardened, ploughing will be possible only with a ' rooter" plough, and more than one pair of bullocks will be needed. This will make the operation more expensive and protracted. On an average, slightly less than one acre of land can be

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*Adopted from a pamphlet by Mr. Guru Din Singh, Farm Manager, published by the Extension Project, Allahabad Agricultural Institute.

ploughed in an 8 hour working day. If possible, the point of the rooter plough should be sharpened every day. This will facilitate ploughing and impose less strain on the bullocks.

In case the ploughing can be done promptly before the soil is hard or after it has been softened by a shower or two, the village plough will serve the purpose. But if there is little moisture in the soil, it will be necessary to use the improved type of plough which has an iron blade or share. When the earth has hardened considerably, it will be impossible to break it up unless the rooter plough is used. The rooter plough does not turn the soil as the improved mouldboard plough does, but merely breaks it up into clods.

Advantages of Dry-weather Ploughing :

1. It pulverizes and loosens soils that would otherwise get extremely hard.
2. It increases the capacity of the soil to absorb and retain moisture.
3. Harmful insect pests and their eggs are brought to the surface as a result of ploughing, and they are either eaten by birds or are destroyed by the hot sunshine; thus reducing the likelihood of damage to the subsequent crop.
4. Many weeds are dried out and killed.
5. Vegetation ploughed into the soil has adequate time to be converted into manure.
6. The early rains which bring a certain amount of nitrogen from the atmosphere are not permitted to flow off the fields as they would if the land were not ploughed.
7. It permits sowing crops at the right time. A popular aphorism states that the best time for sowing *rabi* crops is the last thirteen days of October and the best time for sowing *kharif* crops is the first three days of July, immediately after the preliminary showers. Sowing in the rainy season can begin in time only if the fields have been ploughed and made ready during the dry season.

Very little dry weather ploughing is done at present by farmers; and the meager amount that is done is accomplished with the aid of irrigation from wells, or canals, or after rains have fallen. In the absence of winter ploughing, the sowing of the *kharif* crops is delayed. Since the late seeded crops do not get the full length of time to mature, the yield is adversely affected. Farmers who plough their land during the winter are able to sow their crops of maize, *jowar*, and paddy as soon as the rainy season starts. Their crops have sufficient time to grow properly and ripen normally, making for a crop of better quality as well as a higher yield.

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A Bi-monthly Journal
of
Agriculture and Rural Life

THE
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ALLAHABAD,
U. P., INDIA

September,
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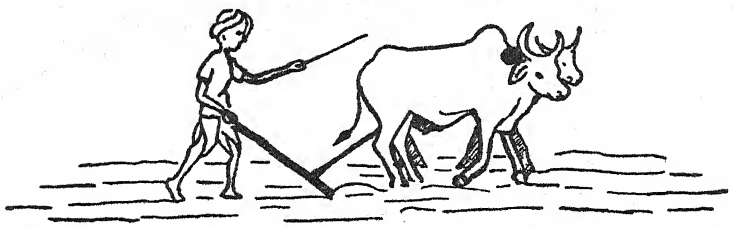

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PRINCIPAL'S REPORT FOR 1952—53

by

H. S. AZARIAH

The Institute made rapid progress due to substantial financial help received from various sources, as mentioned in last year's report. The year was a most eventful one and saw all round progress.

A full fledged college of agriculture, in the words of the University Commission's report, "should be able to make provision not only for instruction and practical training, but also for research and extension work." The activities of the Institute are of these three kinds. In the field of teaching, newer methods were tried to save time and provide more effective teaching. Outlines and summaries of lectures were increasingly used. With provision for darkening a class room, a number of teachers used film strips and movies effectively in their classes. Research has continued on a small scale. Spectacular progress was made in Extension.

A three year Extension Project was started in May 1952, and the progress was gratifying. You will read about it in detail elsewhere in this issue of the Farmer.

Another new phase, was the Literacy Short Courses started in January 1953, under the Directorship of Dr. Frank Laubach with an able staff consisting of Dr. (Mrs) Welthy Fisher, Mr. R. Cortright and Miss E. Mooney. Administratively, this work was placed under the Extension Project. Significant work was accomplished by this able staff.

Perhaps, new to our country, is the establishment of a sisterhood relationship between an institution in India and an American University. The Institute was able to achieve this under the sponsorship of Technical Co-operation Administration. Under the Agreement, the University of Illinois provides certain of their staff for services at the Institute. At the same time, members of the Institute staff could go to Illinois for higher studies and cultural contributions to the life of the campus there. The arrangement has worked out to be satisfactory in every way, and has a stimulating effect on the Institute.

There had been a proposal for many years, for setting up a separate organization to take care of the manufacture of implements. The purpose of such an organization would be to raise funds and provide facilities by which scientific discoveries, inventions and processes developed by the Institu es, may be further developed. Plans were made during the year to establish such an organizatien under the name of Agricultural Development Society. The Constitution has been drafted and is being submitted to the Board of Directors of the Institute for approval. The Provincial Managing Committee of the Society has taken loans to purchase German Reparation machinery and to construct buildings in the Naini compound. Some of the machinery has already arrived.

However, perhaps what is more noticeable to a visitor is the Building Program of the Institute. More than a year ago, the Institute secured the services of the architects, Mayer and Whittlesey, who had helped with the Master plans of the Punjab Capital and the Gujarat University. A Master Plan for the development of the Institute which was presented by the architects, was approved by the Board of Directors a year ago. In brief, the plan places the academic buildings in a curve behind and west of the Engineering building. The residences and the chapel are to come on the north side of the road. The central feature of the plan is to have an allee run from the academic buildings to the river bund between the two men's hostels, with an under pass on the Jabalpur road. The Biology building, the new Maintenance Workshop (near the water tank), and five staff residential units, were completed during the year. The Chemistry building, the Agricultural building, which would house the departments of Agronomy, Horticulture and Agricultural Economics, and the Administration building are now under construction.

And yet, real progress should be noticed, not in the buildings or even in the new activities of the Institute, but in the people who form the core of the Institute; the students, the staff and the alumni.

There had been a steady increase in the number of students. The total number of students in 1952-53 was 347. This is an increase of 11% over 1949-50 figure, the first year in which we had double sections both in Intermediate in Agriculture and the B. Sc. in Agriculture. These students have come to us from Ceylon, Burma, Fiji and Uganda. We also had one student from the United States of America as a Fulbright scholar, from July till December 1952. The corporate life of the students was excellent. In the field of sports, they have continued to keep up the honour of the Institute. Four of our students represented the Allahabad University in the Inter-Varsity Sports, and one student established a new All-India record in Javelin Throw.

The number of staff members has also increased, there are now about 48 teachers of whom only 9 are non-Indians. Mr. John Bathgate, who was on the staff of the Ewing Christian College in 1946-48, has now joined the staff of the Institute as Student Counsellor. During the year, four members of the staff returned to the Institute after further studies abroad. Mr. J. B. Chitambar returned in March 1952, after post-graduate work in Cornell University in Rural Sociology. Mr. C. V. Paul, after completing his Master's work in Agricultural Engineering, returned to the Institute on December 8, 1952. Mr. C. M. Jacob also completed his work for a Master's degree in Agricultural Engineering, and rejoined on February, 17, 1953. Mr. B. C. Das returned to India in February, after securing Ph. D. degree from Iowa State. He joined the staff of the Extension Project, as Director of Extension Training. I returned to the Institute on June 30, 1952, to take charge of the office of Principal from Mr. W. B. Hayes. I had a most profitable year with Professor A. W. Ashby and his associates at the Agriculture Economics Research Institute at Oxford; and my visit to Denmark and Holland to study Co-operatives and Marketing, was very helpful indeed.

Six members of the staff left for further studies abroad. Mr. Dulal Borpujari (Ag. Eng. Dept.), left with his wife on July 29, 1952, for the University of Illinois. Mr. D. Sundaresan (A. H. and D. Dept), left for Kansas State College on August 18, 1952. Miss Pansy Ventura (Extension Dept.), left for the University of West Virginia on September 14, 1952. Mr. Guru Din Singh (Farm Manager), and Mr. H. N. Mehrotra (Biology Dept.), left for the University of Illinois about the end of January 1953, and Mr. I. N. Mathur (A. H. and D. Dept.), left for New Zealand early in February. Mr. J. C. Gideon has transferred himself to the University of Illinois from Purdue.

In connection with the University of Illinois exchange programme, Professor M. H. Alexander arrived in Allahabad on December 10, 1952. He is to help us with animal nutrition in the department of Animal Husbandry. Mr. F. Shuman and Miss F. Kimmelshue arrived on Jaunary 31, 1953. Mr. Shuman has been a very successful County Farm Adviser in Illinois for about 26 years, and has come with rich experience to help us with extension work and with farm problems. Miss Kimmelshue is to help us in the department of Home Economics.

The Institute was well represented in technical conferences. Miss E. Moline, Mrs. S. Koshy, Mrs. G. Azariah, Mrs. C. Warner and Mrs. T. Chitambar, attended the Home Science Conference at Madras; Dr. T. A. Koshy and Dr. C. O. Das, attended the Indian Science Congress at Lucknow; Mr. J. N. Warner, the annual conference of the Indian Society of Agricultural Statistics at Delhi; Mr. J. G. Short, the All India Basic Education Conference at Wardha and the International Conference of Social Work at Madras; Mr. W. B. Hayes, the Horticulture Society of India at Delhi, and Mr. M. Vaugh, the Agricultural Engineering Conference at Delhi.

We continue to get good reports from the alumni who are now in many responsible positions scattered all over India and abroad. We are happy to know that it had been possible for many of them to get scholarships to go for further studies to the United States, England,

Australia and New Zealand. When they return to their country, they would be far more valuable to their people and to their country.

The Institute was happy to welcome distinguished visitors from outstation and abroad. Among those who visited the Institute during the session were: Sri Rajyapal and Srimati K. M. Munshi; Sri S. K. Dey, Administrator, Community Projects; Mr. L. R. Phillips, Representative British Council, New Delhi; Mr. M. L. Wilson, Director of Extension Services U. S. D. A.; Dr. Paul R. Anderson, President, Pennsylvania College for Women; Dr. R. Lloyd, President of Maryville College; Mr. Roger Willson, from the University of Bristol; Professor W. T. G. Airey, University of New Zealand; Professor Allen R. Todd, from Cambridge; Sri W. R. Aryanakum, Secretary, All India Basic Education; Mr. Horace Alexander, Friends Centre Delhi; Dr. I. Moomaw of the Agricultural Missions, Inc.; and representatives from the T. C. A., Ford Foundation, Rockefeller Foundation and Haryard-Yenching Institute, and several others from various sponsoring Missions.

As we look back, we thank God for His mercies, for the progress and growth of the Institute.

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY AND DAIRYING
1952—1953

By

S. S. MAGWAN

I—DAIRY & CREAMERY

During the period of this report 3,51,087.5 pounds of milk and 2,504.1 pounds of cream were supplied from the Animal Husbandry section to the Dairy section of this department. Compared with the Previous year, 35,708.0 less pounds of milk were received but 1,558. 1 more pounds of cream were received. The receipts of milk were highest in March and lowest in September. Cream receipts were highest in January and no cream was received during July and August from this source. In addition 10,502.5 pounds of cream were purchased from our cream suppliers for butter manufacture only. Out of the total milk received, 2,74,820 pounds were sold as bulk fluid milk. The remainder of the milk, that is 76,267.5 pounds, the cream received from the Animal Husbandry section, and the cream purchased from our suppliers were utilised for milk products made in the Dairy.

The average daily sale of fluid milk was 752.9 pounds as compared to 774.8 pounds of last year.

We sold slightly less butter this year, that is 8,692.6 pounds as compared to 9,292.0 pounds of last year. Skim milk sale increased from 22,557.5 pounds of the previous year to 23,329.0 pounds this year.

Since the supply of milk was considerably reduced during the year under report, the Dairy was forced to limit the customers list, keeping in view at the same time the fluctuations in the supply of milk. This has also affected the manufacture of products like *dahi* and ice cream.

During this year we sold 8,293.5 pounds of whole milk *dahi* and 1,525.5 pounds of skim milk *dahi*. All the skim milk *dahi* was supplied to the Institute Cafeteria. During the year 5,334.5 pounds of ice cream and 4,723 ice cream cups and cones were sold. As reported in the previous annual report the power operated ice cream freezer with accompanying cabinet for hardening and storage was a great asset in increased sale of ice cream. With this ice cream freezer it was possible to make some ice cream and store it for retail sale.

Sales of other milk products during the period of this report were: fresh cream 577.5 pounds, cheddar cheese 203.4 pounds, cooking butter 118.2 pounds, and *ghee* 715.6 pounds.

The installation of the new refrigeration compressors was completed during this year. With this installation it was possible for the Dairy to

run the cold storage and the ice plant. The cold storage allowed facilities for storing a sufficient quantity of butter for us to sell during a certain part of the year when we experience butter shortage. The cheese was also stored in a very good condition for marketing. The dairy was not required to buy any ice from outside as it received its full requirement from the ice plant.

The use of the tamper-proof can referred to in the previous report which was developed in the Institute Dairy was continued. No adulteration has been detected since such milk delivery cans were put in use. No bottled milk has been sold since the introduction of such delivery cans. Modification work on our milk delivery units continued throughout the year. In some of these units smaller sprockets (crank wheels) were fixed to replace the conventional sized sprockets. This change helped in driving the units with greater ease and less exhaustion. The construction of a side-car 'Tri-shaw' was a new addition. This was designed on the lines of such units used in countries like Malaya and Burma. The 'Tri-shaw' is the best unit so far, as it runs very smoothly and can be drawn with greater ease. The 'Tri-shaw' has been fixed with a small sprocket too. Repairing work of our delivery units was moderate after all the remodeling we have done so far.

A foot operated butter-print was developed in the Dairy, which cuts at one time nine prints in adjustable sizes. This is a labour-saving device compared to the hand print which was used in the Dairy for many years, cutting only one print at a time. A butter-print scale was added to our equipment during this year.

The herd at the Institute consists of Murrah buffaloes, purebred Red Sindhi cows and different grades of Jersey X Red Sindhi, Holstein X Red Sindhi and Brown Swiss X Red Sindhi. We probably have at any one time a fair distribution of different ages among those in milk. The normal acidity of freshly drawn milk from a healthy cow in India seems to be about 0.03 per cent less than the acidity of similar milk in U. S. A. The acidity of such milk here is expressed as lactic acid seems to be 0.14 per cent. A study in this connection was started in September of the year of this report, to ascertain the exact acidity of our milk, how much it varies and whether or not such factors as season, feed, breed, etc. affect it significantly at all. A sufficient number of samples are tested regularly from this herd. It is reasonable to expect that variations in the acidity that result from the factors listed, and perhaps, others, would be revealed by careful study of the data so obtained. This study is expected to continue for the next year also.

ANIMAL HUSBANDRY

By

M. H. ALEXANDER

MILK STOCK

After correcting the average milk production for the year 1951-52 to terms of milk actually produced per milking animal in that year and comparing that production with 1952-53 there is shown a decrease of

518.3 pounds, or 12.8 percent from the previous year. It should not be a matter for discouragement that this report shows a decrease in average production of 12.8 percent while last year showed an increase of 10.55 percent over the year 1950-51. The figures for the year 1950-51 and 1951-52 are for total lactations some of which extended far back into the previous years and therefore give a distorted picture. It is a matter for concern that the herd average for 1952-53 is only 3510.6 pounds. The average production of the cow herd was down 14.7 percent from last year, while the production level of the buffalo herd remained practically the same. It must be recalled that it is much easier to maintain high production in a herd of 10 to 12 animals than in one of 90 to 100. However, in this connection it should be pointed out that buffaloes in general are capable of higher production than cows. The average for the whole of India is more than two and a half times greater than for cows. This indicates that our buffalo herd is probably below what is should be. For purposes of comparison it is noted that the buffalo herd at the Aarey Colony Farm, Bombay, consisting of about 13,000 head, produced during 1952-53 about 5,600 pounds each, a remarkable achievement considering the large number involved.

Table II shows an average of 3907 pounds of milk for the purebred Sindhis. A calculation of the production of all the corssbred cows shows an average of 4333 pounds. However, if allowance is made for the difference in days in milk and of dry time the average of the purebred Sindhis would be 4303 pounds if the daily milking average remained at 11.66 pounds. This is not a significant difference. The daily overall average leads to the same conclusion with 10.0 pounds for the Sindhis and 10 pounds for the crossbred, which again is not significant. The data presented in this table show a significantly higher production for the Brown Swiss X Sindhi and the Holstein X Sindhi crosses than for the Jersey X Sindhi crosses.

Table III gives a further analysis of the data presented in table II In this tabulation there are 46 animals carrying varying degrees of Jersey and Sindhi inheritance with an average milk yield of 4333 pounds and a daily milking average of 13.5 pounds. The Brown Swiss by Sindhi records show an average of 5515.0 pounds with a daily milking average of P5.3 pounds. The 6 Holstein Friesian by Sindhi records averaged 5471 pounds and 16.4 pounds daily. If the 46 Jersey by Sindhi cows had been Brown Swiss by Sindhi instead of Jersey by Sindhi and had produced at the reported Brown Swiss by Sindhi level the increased return at the current price of milk would have been Rs. 6735/- more. If the 46 cows had been Holstein Friesian by Sindhi instead of Jersey by Sindhi and had produced at the reported level of the Holstein Friesian by Sindhi animals the rupee returns would have been increased by the amount of 8841/-. Either circumstance would have more than wiped out the rupee deficit in operating the herd for the period.

The goal for numbers in the different catagories under which the herd is being operated at present has not been reached. The present plan placed in operation on March 20, 1953 sets up the following goals for numbers of animals in each category :—Purebred Red Sindhis, 25, plus followers. Murrah Buffaloes, 20, plus followers. Jersey X Sindhi, 70, plus followers.

The achievements as indicated here are as follows :—Purebred Red Sindhis, 21, plus followers. Murrah Buffaloes, 10, plus followers. Jersey X Sindhi, 83, plus followers.

This is an increase of 4 for Red Sindhis, 1 for Murrah buffaloes towards the goal, and an increase of 4 away from the goal for the mixed herd. These groups are all due for serious culling during the new year. It is probable that the situation in the buffalo herd call for a revision in the plans for its continuance.

FEMALE YOUNG STOCK

The department began the year with 109 head of female young stock and ended the year with 125 head, a 14.5 percent total increase. Table IV indicates that some progress was made in the matter of better growth. Last year the average weight at an average age of 3.58 years was 628 pounds. This year at an average age of 3.45 years it was 637.4 pounds. The weights reported are partly due to poor condition and reflect improper nutrition. These animals should and probably could grow out to an average of 900 pounds at maturity if properly fed from birth. A 250 pound increase in body weight at first calving according to results achieved at the University of Missouri, U. S. A. could mean an increase in milk production of 1500 pounds per year. This converted into rupees in terms of increased production from 114 milking animals, the number in the herd on April 1, 1953, would constitute an increased income of Rs. 3,800/. The increased cost of feeding these animals out properly would be justified in increased returns. Proper nutrition during the development stage of the heifers would also be reflected in earlier maturity, earlier first calving age, and shorter calving intervals, all of which would result in greater lifetime production. All of these factors together would result in a lower cost of production.

MALE YOUNG STOCK

Twelve male calves were on hand at the beginning of the year. Sixty two were born, 1 (a Jersey) was purchased, 49 were sold and 7 died, leaving 19 at the end of the year. Apparently there is a brisk demand for improved bulls, which should encourage us to a serious consideration of how to improve the quality of the stock which we offer for sale.

FEEDING

Feeds and feed mixtures for the herd during the past year have been unsatisfactory in some ways. In the first place this herd was fed only on green fodder or silage for its roughage ration. An all green fodder or silage ration is apt to be deficient in vitamin D due to the fact that either none or possibly only a small part of the plants get to maturity in open sunlight, which inhibits the development of vitamin D in the plants. A lack of vitamin D results in breeding troubles and may be responsible for other physiological disorders. Further, the arrangement for getting green fodder to the herd was awkward, due to the interdepartmental organization for harvesting. This resulted in radical changes, from time to time, when feeding was switched from legumes to non-legumes and

back, and sometimes also in spoiled feed because of delay between time of delivery of feed from farm to cattle yard and time of processing for feeding. This resulted in a depressing influence on production. In the second place the concentrate mixture used was too high in protein for the best results. The digestible protein content of the mixture was at times as high as 20 percent when good feeding practices demonstrate that it should never be more than 15 percent, and under certain conditions not more than 10. Some of these conditions have been corrected. Others should be greatly helped as the program for ensuing crops undergoes change.

Plans are laid for various experimental feeding projects for the coming year which it is hoped will point to some positive answers for the problems of growing out young stock and feeding for higher milk production. The physical condition of the herd was not good at the close of the year. The animals were undetweight due to poor condition and were poorly developed. Better feeding than has been practised in this herd in the past year will be necessary before a satisfactory production level can be reached and before a satisfactory basis for selection can be established.

ARTIFICIAL INSEMINATION

During the year there were 22 male calves and 20 females born into the herd by artificial insemination. During the same period there were 40 males and 31 females born from natural services. A total of 96 artificial inseminations of cows were carried out and 126 natural inseminations given.

The U. P. Government Key Village Block Artificial Insemination Centre, operated in co-operation with the Institute was maintained throughout the year. The continuance of this project has not proved satisfactory from the operational standpoint. It is probable that our cooperation will be discontinued soon.

Poultry, Sheep, Goats, and Swine

Our poultry and small stock have continued throughout the year on about the same basis as last with no change in breeding and feeding policies. These projects all showed financial losses for the year. There is room for improvement here in the breeding and feeding practices.

Poultry :—The size of the flocks was reduced from 163 to 92, about the size we had at the start of the previous year. There were also a few Austrolope chickens and some ducks and geese.

Sheep :—The number of sheep remained about the same as during the previous year. The flock consists mainly of Hissardales, with a few corriedale ewes and one cross. The flock numbered 32 at the beginning and 37 at the close of the year.

Goats :—We continued to maintain small flocks of Bari Bari and Jumna Pari goats. The year started with 18 Bari Bari and 14 Jumna Pari goats and closed with 22 Bari Bari and 15 Jumna Paris. Only 4 goats died during the year. Births and sales accounted for the differences.

Swine :—A very small swine programme continues. There were 11 head on hand at the start and 8 remained at the end of the year. Several litters were raised for meat. There were 21 births. 3 males were sold, 3 head died and 18 were butchered. As there seems to be some increase in local demand for pork, it is proposed to increase the number next year.

Departmental Reorganization

On April 1, 1953 the department of Animal Husbandary and Dairying was divided into two departments and will operate in the future as the department of Animal Husbandry and the department of Dairy Technology. Separate quarters will be provided for the departments by allocation of the present dairy building to Animal Husbandry and the erection of a new building for Dairy Technology.

TABLE I

Comparison of Milk Production for years 1951-52 with 1952-53.

Overall Production Average

Year	Division	No. of animals	Lbs. Milk per animal	Lbs. difference from previous year	Percentage Difference
1951–52	Whole Herd	101 6	4029		
	Cows	91.6	4061		
	Buffaloes	10.0	3735		
1952–53	Whole Herd	110.6	3511	—518.3	12.8
	Cows	98.9	3485	—575.8	14.7
	Buffaloes	11.7	3726	— 9.0	0.0

TABLE II

Lactations Completed During 1952-53.

Breed or Grade	No. of Lactations Completed	Average Yield in lbs.	Average days in Milk	Average* days dry Preceeding Lacts	Daily milking average	Daily Overall Average *	No. of Heifers
Red S indhi ...	12	3907	335	56	11.7	10.0	3
1/16 Jersey x 15/16 Red Sindhi ...	3	5113	370	124	13.8	10.4	1
1/8 Jersey x 7/8 Red Sindhi ...	14	4472	363	105	12.3	9.6	5
1/4 Jersey x 3/4 Red Sindhi ...	15	4367	311	95	14.0	10.8	1
Jersey x Red Sindhi ...	7	3875	292	63	13.3	10.9	...
5/16 Jersey x 11/16 Red Sindhi ...	2	5448	420	...	13.0	...	2
9/16 Jersey x 7/16 Red Sindhi ...	1	4678	335	61	14.0	11.8	...
5/8 Jersey x 3/8 Red Sindhi ...	2	4451	266	65	16.8	13.1	...
3/4 Jersey x 1/4 Red Sindhi ...	2	2143	180	63	11.9	8.8	...
Jersey ...	2	5128	651	...	7.9	...	2
1/16 Brown Swiss x 15/16 Red Sindhi	1	5687	543	...	10.5	...	1
1/8 Brown Swiss x 7/8 Red Sindhi ...	3	5458	351	73	15.6	12.9	1
1/4 Brown Swiss x 3/4 Red Sindhi ...	5	5515	343	133	16.1	11.6	...
1/16 Holstein x 15/16 Red Sindhi ...	3	5370	340	117	15.8	11.8	...
1/8 Holstein x 7/8 Red Sindhi ...	1	5337	306	126	17.4	12.4	...
3/16 Holstein x 13/16 Red Sindhi ...	1	3971	312	55	12.7	10.8	...
3/8 Holstein x 5/8 Red Sindhi ...	1	7408	357	188	20.7	13.6	...
Miscellaneous ...	6	4760	390	130	12.2	9.2	2
Murrah (buffalo) ...	8	3540	283	164	12.5	7.9	3
Total or Weighted Average for the Herd	89	4447	340	100.0	13.3	10.3	21
Total or Weighted Average for last Year	60	4442	317	129.8	13.8	10.1	10

* Heifers omitted from these calculations.

TABLE III

Herd Group Averages and Comparisons

Group	No. of animals	Ave. lbs. milk	Ave. days in milk	Ave. days dry	Daily Milk average	Daily lbs. increase over weighted average	*Rupee increase per year
Jersey by Sindhi cross	46	4333	325	88	13.5	0.25	
Brown Swiss by Sindhi Cross	9	5515	356	98	15.3	1. 8	6735/-
Holstein Friesian by Sindhi cross	6	5471	333	120	16.4	2.37	8841/-

*This is figured at Rs. 1/- for each 4.5 lbs. of milk sold.

TABLE IV

Average Age and Weight at the First Calving of 31 Heifers Transferred to Milk Stock, 1952-53

Breed or Grade	No. of Animals	Average Age in Years	Average Weight in Pounds
Red Sindhi ...	5	3.36	650
1/32 Jersey x Sindhi ...	2	3.03	485
1/16 Jersey x Sindhi ...	3	3.16	540
1/8 Jersey x Sindhi ...	5	3.62	546
1/4 Jersey x Sindhi ...	3	3.16	513
9/32 Jersey x Sindhi ...	1	2.75	570
3/8 Jersey x Sindhi ...	2	2.60	610
7/16 Jersey x Sindhi ...	1	2.77	600
17/32 Jersey x Sindhi ...	1	2.33	690
1/32 Holstein x Sindhi ...	1	3.14	530
1/16 Holstein x Sindhi ...	1	3.35	470
Murrah (Buffalo) ...	6	4.58	928
Total or Weighted Average ...	31	3.45	637.4
Total or Weighted Average for Last Year	24	3.58	628

REPORT OF THE AGRONOMY DEPARTMENT, 1952-53

By

A. K. Ghosh and R. P. Singh

Research On Crops

Sugarcane :

Sugarcane (first ratoon) *varietal and manurial experiment :—*

The manurial experiment which was conducted last year, on two varieties of plant canes was repeated on the first ratoon. The varieties included were Co 331 and Co 453. The manures were applied on the ratoon at the rate of 100 pounds of nitrogen per acre, as was done the previous year in the case of the 'plant' canes. As castor cake could not be procured, groundnut cake was substituted in its place. The other two manures, amonium sulphate and farm yard manure, were repeated along with the control (no manure). The manures were applied as top dressings on 7th August 1952. The data on the yield of canes, juice and *gur* (crude sugar) were analyzed and the following results obtained:

(a) Yield of canes—No difference in the yield of canes was significant due to either varieties or manures.

Varieties

	Co 331	Co 453
Total yield from 3 plots in seers	4868.0	4322.5
Yield in maunds per acre	391.64	347.54

Manures.	Ammonium Sulphate	Groundnut Cake	Farmyard Manure	Control (no manure)
Total yield from 6 sub-plots in seers	2503.5	2340.0	2197.0	2150.0
Yield in maunds per acre	402.8	376.5	353.5	345.9

(b) Yield of juice—the differences in the yields of juice due to either varieities or manures were not statistically significant.

Varieties

	Co 331	Co 453
Total yield from 3 plots in seers	2595.0	2306.5
Yield in maunds per acre	208.8	185.6

Manures	Groundnut Cake	Ammonium Sulphate	Farmyard Manure	Control
Total yield from 6 sub-plots in seers	1287.5	1238.5	1233.5	1142.0
Yield in maunds per acre	207.1	199.8	198.2	183.8

(c) Yield of *gur* — As in the case of the yield of canes and juice, there was no significant difference in the yield of *gur* due to either varieties or manures.

Varieties

	Co 331	Co 453
Total yield from 3 plots in seers	461.5	399.5
Yield in maunds per acre	24.8	21.4

Manures	Farmyard Manure	Ammonium Sulphate	Groundnut Cake	Control
Total yield in seers from 6 sub-plots	218.5	217.5	215.5	209.5
Yield in maunds per acre	35.15	34.99	34.67	33.70

Sugarcane seed treatment and manurial experiment:

A two-factor experiment, to test the effect of manurial treatments and seed treatments on the yield of sugarcane Co 453 was set up. The manurial treatments consisted of farmyard manure, groundnut cake, ammonium sulphate, and control. These manures were applied on 8th August 1952 as a top dressing, at the rate of 150 pounds of nitrogen per acre. The seed treatmet was applied to protect the crop from white ants. It consisted of treating the cane sets with gammexane Dust D. 025 and control (untreated sets). The sets were treated before planting. The planting was done on 25th February 1952 in a randomized-block layout with six replications. Each block consisted of four plots, one for each of the four manurial treatments. Each plot was further divided in two sub-plots, one plot was 52 ft. x 15 ft. (the net size being 46 ft. x 9 ft.). The row to row planting distance was 3 ft.

The crop was harvested on 24th December 1952. The data on the yield of canes were analysed statistically. The results showed significant difference due to blocks, manures, and seed treatments.

Following is the summary of the result obtained:

Manures.—The significant difference in the yield of canes due to manures at the 5% level was 106.67 maunds. The yield resulting from treatment with ammonium sulphate was significantly greater than that from the other treatments, but the yields from plots treated with farmyard manure and groundnut cake were not significantly different from the control.

	Ammonium Sulphate	Farmyard Manure	Control (no manure)	Groundnut Cake
Total yield from 6 plots in seers	3400.0	2860.5	2812.0	2782.5
Yield in maunds per acre	745.28	627.02	616.39	609.93

Seed Treatments

The significant difference in the yield of canes due to seed treatments at the 5% level was 213.34 seers and the yield resulting from the untreated sets was significantly greater than the treated sets.

	Untreated Sets	Treated Sets
Total yield from 24 sub plots in seers	6099.0	5756.0
Yield in maunds per acre	668.20	630.85

Jowar:

Jowar varietal experiment:

The trial of jowar varieties for grain production was continued this year. The varieties included were Godgarya, Aispuri, Farm selection, and Karma. A randomized block layout was prepared and there were six replications. The size of each plot was 60 ft. x 16 ft. the net size of each plot being 65 ft. x 12 ft. The seed was sown in rows, 2 feet apart on 1st July 1952.

The crop was harvested on 13th November 1952. The analysis of the data on yield of grain showed that a difference of 24.51 seers between the total yield of varieties from the six plots was necessary for significance at the 5% leval. A summary of the results is presented below:—

	Karma	from Selection	Godgarya	Aispuri
Total yield from 6 plots in seers	109.5	103.5	98.5	24.5
Total yield in maunds per acre	28.55	26.99	25.68	6.39

The ratios of the weight of whole ear heads to the weight of grains of each variety were as follows.

Farm	Karma	Godgarya	Aispuri
1.21	1.25	1.34	1.93

Likewise, the ratios of the weights of stover to the weights of grain were found to be.

Karma	Farm	Godgarya	Aispuri
8.8	9.2	11.1	17.6

Jowar Fodder Experiment

The experiment was set up to test three different seed rates and five different spacings, including broadcasting. The seed rates were 8 seers, 10 seers, and 12 seers per acre. The spacings were 1½; 2, 2½ and 3 feet between rows and broadcasting. A randomized block layout with 4 replications was used. The size of each plot was 48 ft. x 12 ft. The sowing was done on 30th June 1952.

The green fodder was harvested at the booting stage on 22nd September 1952. The data on the yield of fodder were analyzed statistically. The seed rates showed no significant difference but a highly significant difference was obtained for spacing. The amount of difference necessary for significance at the 5% level was 174.84 seers. The following results were obtained.

	2 ft. spacing	1½ ft. spacing	2½ ft. spacing	3 ft. spacing	Broad-casting.
Total yield from all plots of the same spacing (seers)	2931.5	2869.0	2544.5	2531.0	2417.0
Yield in maunds of green fodder per acre	461.71	451.87	400.76	398.63	380.68

Cotton

Cotton varietal Experiment.

The cotton varietal trial to test four varieties of medium staple cotton was continued using a randomized block layout. The varieties were 44/M 42,C.AM/4. P.AM, and 100 F and there were six replications. The size of each plot was 74 ft. x 12 ft. the net size being 70 ft. x 8 ft. and there were six rows per plot. The sowing was done on 3rd July 1952 and the seed rate was 10 pounds per acre.

The data on the yield of raw cotton including seed, showed a highly significant difference between the varieties and also between the blocks. The least significant difference between the varieties was found to be 9.37 pounds. The following results were obtained.

	100F	44/M42	P.AM	C.AM/4
Total yield from six plots per variety in pounds	44.30	43.20	32.20	28.25
Yield in maunds per acre	7.00	6.83	5.09	4.46

Green Manure

Green Manuring Experiment.

An experiment was set up to see the effect of four different leguminous crops, when ploughed into the soil as green manure, on the following

wheat crop. The treatments included were sannhemp, cowpea, *mung*, *dhaincha*, and no manure. A randomized block layout was used with six replications. The size of each plot was 73 ft. x 12 ft. (the net size being 71 ft. x 10 ft.). The sowing of the green manure crops was done on 7th June 1952. They were ploughed into the soil on 20th September 1952.

Wheat (C. 13) was sown at the rate of 30 seers per acre in the above layout on 11th October 1952. There were 12 rows per plot.

The crop was harvested on 30th March 1953 and the data on the yield of grain analyzed. Both the treatments and block showed that there was a significant difference between the total yields. The significant difference for the treatments was 12.036 seers. The following results were obtained.

	Sannhemp	Cowpea	Mung	Dhaincha	Control
Total yield of wheat from six plots in seers	97.0	82.5	82.0	78.9	49.5
Yield in maunds per acre	24.80	21.09	20.96	19.93	12.65

Wheat

Wheat Village Samples Experiment.

Twentyfour samples of wheat collected by the Extension Department from the surrounding area were put under trial in a randomized block layout. There were four replications and the size of each plot was 60 ft. x 6 ft. (the net size being 58 ft. x 4 ft). The sowing was done on 29th October 1952 at the rate of 30 seers per acre.

The crops was harvested on 2nd April 1953 and the yield data for the grains were analysed. There was a significant difference between the yields of varieties. The difference between varieties required for significance at the 5% level was 3.54 seers. The results follow.

Sample No.	**Yield from 4 plots in seers (per sample)**	**Yield in maunds per arcre**
1,6,24	21.00	24.64
21	20.50	24.05
14,19	20.00	23.46
13,17	19.50	22.88
5	19.25	22.58
4,10,15,16	19.00	22.29
18	18.75	22.00
3,11	18.00	21.12
7,8,20	17.50	20.53
2,9	16.50	19.36
12	16.25	19.06
22	15.50	18.18
23	15.00	17.60

Note. The names of the villages from where the best yielding samples were obtained are as follows.

Sample 1 —Bhagdewa; Sample 6 —Dandi; Sample 24 Mundi Ka Purwa. Most of these samples contained mixtures of different strains and required a considerable amount of rogueing.

Wheat rust nursery

A nursery was laid out to co-operate with the Government in a study of the occurrence of wheat rusts. An aeroscope was fixed near this nursery to expose glass slides to study the dissemination of rusts. The rusts were first observed on the wheat crop on the 9th of February.

Barley

Barley Village Samples Experiment

Fourteen samples of barley collected by the Extension Department from the surrounding area were tried in a randomized block layout. There were four replications. The size of each plot was 45 ft x 8 ft (the net size of each plot being 43 ft x 6 ft) with ten rows per plot. The sowing was done on 27th October 1952 at the rate of 30 seers per acre.

The crop was harvested on 16th March 1953. The analysis of the data for the yield of grain did not show any significant difference between the varities. The results are given below.

Sample No.	Yield of grains from four plots in seers	Yield in maunds per acre
5	29.0	30.60
6 and 14	28.0	29.55
10 and 11	27.5	29.02
2,12 and 13	26.5	27.96
3 and 9	26.0	27.44
7	25.5	26.91
4	25.0	26.38
8	24.0	25.32
1	19.0	20.05

Barley Varietal Experiment.

The barley varietal experiment was continued. Five varieties were sown in a randomized block layout with six replications. The varieties included were T 35/44, T.300A, T. 20., T 34/86, and T 34/66. The size of each plot was 58 ft x 10 ft, (the net size being 56 ft x 8 ft) and there were 10 rows per plot. The sowing was done on 27th and 28th November 1952 at the rate of 30 seers per acre.

The crop was harvested on 13th March 1953 and the data on the yield of grain analyzed. There was no significant difference between the varieties. The following was the result:

	T. 35/44	T. 300A	T. 34/86	T. 34/66	T.20
Yield from 6 plots in seers	43.5	41.0	37.5	34.0	31.0
Yield in maunds per acre	17.62	16.61	15.19	13.77	12.56

Gram

Gram Varietal Experiment

A latin square layout was used to test five varieties of gram. The varieties were: No. 17, N. P. 58, T. 87, N. P. 56 and Local. The size of each plot was 35 ft x 20 ft (the net size being 33 ft x 18 ft) and there were 20 rows in each plot. The sowing was done on 17th October 1952, at the rate of 30 seers of seed per acre.

The crop was harvested on 18th March 1953 and the data collected on the yield of seeds were analysed. There was no significant difference between varieties. Following was the result:

	No.17	T.87	N.P.56	N.P.58	Local
Yield in seers from five plots	67.5	67.5	65.5	63.0	63.0
Yield in maunds per acre	24.75	24.75	24.01	23.10	23.10

HERBICIDE TESTS

This year the department received from the Dow Chemical Company, U. S. two herbicidal chemicals; namely Sodium T. C. A. 90% and Esteron 245. Agroxone and Sinox were available from local sources.

The chemicals were tried at different concentrations and in different seasons on various grasses and weeds that are commonly found on the Institute farm.

Treatments were made at different times and at various dosages as indicated. Materials in solution were applied with a hand sprayer to the point of "run off". Results are shown in Table I.

Sodium TCA 90% was found more effective on grasses than on other plants. It was particularly effective in the control of *dub* (Bermuda grass) and *janai*. *Dub* and *janai* grasses were killed so completely that new growth of green leaves was not again observed until about a month had passed, whereas only the tops of *kush* and *kans* were injured. The leaves of both were markedly scorched. Sodium TCA 90% was also sprayed on the freshly cut stubble of *kush* and *kans*, but it did not produce any observable change in the rate or amount of new growth.

Esteron 245 was tested mostly on plants with wide leaves. The results obtained are shown in Table I. It totally killed *kakronda*. Esteron killed the leaves of *jharberi* but it did not kill the plants. The effect of the chemical could be observed within a few hours after its application. However, it killed papaya plants completely.

Agroxone and Sinox were also applied to different weeds including *dhatura* or cocklebur which was affected only when heavy doses were used. Sinox was sprayed on cocklebur and it killed the leaves but the stem remained green.

RESULTS OF THE HERBICIDAL TRIAL

TABLE I.

No.	Name of the Weed.	Hindi Name	Date of Application	Name of Chemical	Dosage	Remarks.
1.	*Cynodon dactylon*	*dub*	9-10-52	Sodium TCA 90%	½ to 1 lb in 3 gals water for 15′ × 30′ plot	Tops killed (new growth was observed after about one month.)
2.	*Andropogon pertusus*	*janai*	9-10-52	,, ,,	,, ,,	Tops killed.
3.	*Eragrostis cynosuroides*	*kush*	11-10-52	,, ,,	,, ,,	Leaves scorched.
4.	*Ficus religiosa*	*pipal*	9-10-52	,, ,,	¾ lb in one gallon of water	Leaves affected only (stem remained green)
5.	*Saccharum spontaneum*	*kans*	22-10-52	,, ,,	57 gms in 3 gallons of water for 400 sq. feet. plot	Leaves scorched.
6.	*Cyperus rotundus*	*motha*	25-11-52	Agroxone	5% dust	Tops killed
7.	*Xanthium strumarium*	*chhota dhatura*	18-9-52	1 lb (approx.) dust for 30 × 8′ plot	,,	Partly killed.
8.	*Convolvulus arvensis*	*hiran kuri*	26-11-22	,,	,,	Tops killed.
9.	*Vicia hirsuta*	*akri*	,,	,,	,,	,, ,,
10.	*Chenopodium album*	*bathua*	,,	,,	,,	,, ,,
11.	*Laggera aurita*	*kakronda*	9-10-52	Esteron 245	1 tablespoon in 1 gallon water. for 288 sq. ft. plot.	Killed.
12.	*Zizyphus rotundifolia*	*jharberi*	10-10-52	,,	3 spoons in 1 gallon water	Leaves killed but stem remained green

REPORT OF THE AGRICULTURAL ENGINEERING DEPARTMENT

1952-1953.

By

Mason Vaugh

The activities of the Engineering department along lines of research are mainly financed under a grant from the Agricultural Department of the Uttar Pradesh Government and are fully reported on in a report to the Department. The following is a summary of what was done during the year.

Water Lifts.

The research problem which gave most definite results during the year was one on water-lifts. Three phases of the problem were under active study, (1) the problem of lifting large quantities of water from canals in cutting (below ground level) ponds and shallow wells, (2) the lifting of water from deeper wells for irrigation and (3) the lifting of household water from village wells. Work was done on all three phases during this year.

We completed and put on the market a low lift hand pump employing novel actuating mechanisms and a new type of "washer" or piston packing. This has been made in two sizes, each calculated to absorb the full reasonable capacity of a man. The smaller is suitable for lifts up to 10′ or so. It will work mechanically at somewhat higher lifts but becomes too heavy for one man to work. The larger size is suitable for lifts of only 3′ to 4′ but gives something like double the capacity. A bullock-driven model has been built and given preliminary tests but has not been tested in actual service.

The Persian wheel has long been recognised as a valuable type of lift for animal power operation. Its great weakness has been the rapid wear of the bucket chain. The manufacturing techniques and other problems have been worked out for a chain with rubber bearing bushings in the chain in the hope that this will somewhat lighten the load and greatly lengthen the useful life of the chain. A model has been built and installed and should be tested in the next season.

Village household or domestic water supply has long been a challenge. It has been recognised that contamination of the village wells was from the top, through the ropes and buckets used for drawing water from the well. Dr. Rutherford of the India Village Service has worked on a self-dumping bucket which would allow the well to be fully enclosed. It has seemed to us that a mechanical pump properly made should be better and probably as cheap if not cheaper. The same mechanical principles worked out for the working head of the low-lift

hand pump have been adapted to the working head for domestic supply. One has been under test at the rainfed farm well which is just beside a village thoroughfare and is used to supply water for six animals and a family and in addition is used by many people passing by who stop to drink. This working head has given excellent results and can be used with the ordinary hand pump cylinders available. We believe that with adequate manufacturing facilities it will be both cheap and durable and easily repairable. Work is in progress on an improved type of cylinder but this is, as yet, not entirely successful. Work is continuing and two other pumps have been built and installed, as test units. We expect to have a village model hand pump for domestic water supply on the market in the next year.

Harvesting and threshing.

Work continued during the year on harvesting and threshing methods. The combine worked better than in previous years and harvested about 1/3 or the wheat crop. It still does not seem likely to be a suitable substitute for the hand sickle in India in its present form. Under the conditions prevailing this year, the mover with reaping attachment did not satisfy the farm management and was not fully utilised. Work on the bullock-driven harvester-reaper was abandoned as it did not seem likely to be successful. A better method of harvesting, to use in small fields and with a dry crop, is still needed but no satisfactory woking principle has yet been evolved.

We feel that rather more progress was made on threshing. While we have used an American thresher with fair succcess for many years, its capacity is disappointing and the cost of working is high. We make good *bhusa* (pulverished straw) with a hammer mill but again the cost is high and the capacity low. The principle followed in the method of trampling the straw with bullocks and improved in the use of the olpad thresher, seems to be correct but to need improvemet to allow the application of mechanical power. The use of olpad threshers with tractors, or disk harrows with tractors, seemed hardly suitable for village conditions so work was started last year in a preliminary way with putting the crop through a chaff cutter. This year further work was done using a big hay chopper. This seems to have many of the features desired. The capacity is large; in the preliminary trials about 75% of the straw was reduced to usable *bhusa* and most of the grain was threshed. It should not be difficult to combine this apparatus with winnowing and grain-dressing mechanisms. Work will be continued on the process in the next few years. The short season available for the tests is a handicap.

Rainfed Farm.

Work was continued on cultural methods. Results on the rainfed farm indicate the urgent need for agronomic research on seed rates, on row spacing, and on the various methods of growing mixed crops in order to utilise more animal drawn implements instead of so much hand labor. Progress has been made in the use of cultivators for seed bed preparation and for the interculture of crops. The basic design of the new Wah Wah cultivator seems to be excellent. It is still somewhat heavier than desirable.

Progress with finding a growing "fence" plant has been disappointing. We have been looking for a thorny creeper which could be trained into a thin "fence" by interlacing the vines and which would not be eaten by goats and cattle. Bouganvilia appears suitable but hard to start. We would welcome any report of a thorny creeper not palatable to cattle or goats and which starts easily from seed. The vines should be fairly stiff and woody, not thin and fleshy. Wire fence does not seem possible because of the high cost and because of the tendency of people to cut or break out sections of it to make openings or to get the wire for other purposes.

We have been interested in studying the intensity with which our work animals are used. The following table is a summary of work done with two pairs of animals during the year:

		pair days.
Plowing with U. P. No. II, (dry weather and stubble plowing)	...	180.0
Plowing with U. P. No. II (Green manuring, mainly *sanai*)	...	17.5
Plowing with U. P. II, (Between *arhar* rows in Winter)	...	44.5
Interculture of standing crops	...	50.5
Seed bed preparation with cultivators	...	25.0
Disk harrowing of seed beds	...	30.0
Seeding with cultivator seeding attachment	...	32.0
Leveling of fields	...	98.0
Carting of crops	...	47.0
Total	...	524.5 pair days

In addition to the above work by pairs, the female buffalo worked for the following as a single animal:

		days
Planking of fields	...	51.5
Spike tooth harrowing	...	4.5

The two pairs worked an average of 262 days each. If we exclude 52 Sundays and 7 religious and public holidays observed, this leaves 44 working days when thcy were not employed. Had threshing or drawing irrigation water been done by bullocks they wouid have been practically fully occupied. The 49 days of levelling work per pair might not be available on every farm but on most farms the equivalent time could be used for drawing irrigation water.

Implement Manufacture.

Implement sales for the year may be of some interest. The

table shows the kind and number of implements and hand tools sold during the year, all made in the Institute workshop.

Garden rakes	...	195
Garden hoes,	...	553
Shabash plows, iron parts only	...	240
Shabash plows, complete	...	543
Shabash cultivators	...	133
Wah Wah plows	...	68
Wah Wah cultivators	...	89
U. P. No. I plows	...	82
U. P. II plows	...	62
Winnowing fans	...	100
Levelling scrapers	...	64
Earth borers (post hole and latrine)	...	43
Shabash spare shares	...	341
Garden *kurpis*	...	222
Shabash plow spare parts	...	52
Sickles	...	22
U. P. No. II spare parts	...	37
Victory plow parts	...	4
Nagpuri yokes and parts	...	19
Spare shovels for cultivators	...	88
Low lift hand pumps	...	12
Furrowers	...	29
Sweeps	...	27
Loppers	...	11
Hedge shears	...	14
Replacement bolts and nuts	...	90
Miscellaneous other small parts and items	...	30

The total value of sales was about Rs. 50,000, just about twice the sales in previous years. As this report is being prepared, work is going on to remodel the buildings in the Naini compound to make them suitable for the implement factory. It is expected that the implement factory will function there from about the beginning of January, 1954.

The implement sales work faces two major difficulties, one of slow collection from Government departments which insist on credit supply but are slow to pay, and the other from the failure of the railway to move goods offered. During part of the year under report, there was considerable difficulty getting booking in all directions and we have not been able to get a single shipment accepted for Assam or North-East Bihar and North Bengal for the last six months or more. Some orders have had to be kept pending for nearly a year because the railway will not accept the shipment.

The Eastern Economist reports on the food prospects for 1954. It is learnt that India will probably not need to import any food-grains in 1954. The favourable monsoon of 1953 and the ideal *Kharif* crop coupled with satisfactory storage facilities is expected to make 1954 a record year. The only food import in 1954 will probably be ten lakh tons of wheat which India has to buy annually for the next three years under the International Wheat Agreement. Rice has heretofor been the costliest item of food imports. Of the 40 lakh tons imported last year, rice alone cost a major portion of the Rs. 200 crores of valuable foreign exchange.

REPORT OF THE BIOLOGY DEPARTMENT 1952-53

By

W. K. Wesley R. N. Srivastava, and T. A. Koshy

General:

The department continued its three-fold programme of teaching, research and extension. The teaching programme continued as before. For the first time a Research Assistant was added to the staff of the department. This has made it possible for us to tackle some of the immediate problems relating to diseases and pest on the Farm as well as in the villages. The Extension Project of the Institute brought to our attension several such problems in the neighbouring villages which need to be solved for improving agriculture in this area. Consequently, the Research Assistant spent much time visiting villages and studying the nature of the problems. He was also the Extension contact man of the department, thus forming a link between research and extension. As in the previous year a short course in 'Phytopathological Methods' was offered to IV year Agriculture students during the autumn vacation. Technical help was rendered to some research students of the Allahabad University who came for such help. To many others advice on Biological matters was given by correspondence.

Members of the staff spent considerable time in conference on the design of the new building for the Biology Department. Plans were finally approved by the Board of Directors and construction was started in September 1952.

Research: Botany and Plant Pathology:

Some samples of fungicides,herbicides and insecticides were received from Amrit Lal and Co., Bombay, for trials. Accordingly tests were made to determine the effect of herbicides. Some initial experiments were made with Kathon M-7 a product of Rohn and Hass Company, Washington Square, Philadelphia 5, Pennsylvania, U. S. A. Kathon M-7 contains 49.8% of dimethylamine salt of 2, 4-Dichlorophenoxy acetic acid (Equivalent to 41.5% 2, 4-D.) It is readily soluble in water. The trials were conducted on fields of sugarcane, *jowar*, maize and pasture. All trials were made in the post emergence period. This herbicide was found to be quite selective. Following is the list of susceptible and resistant weeds:—

Susceptible Weeds	**Partially Susceptible**	**Resistant Weeds**
Amarantus viridis	*Euphorbia hirta*	*Euphorbia thymifolia*
A. spinosus	*Blumea laciniata*	*E. hypericifolia*
Tridax procumbans	*Justicia simplex*	*Zizyphus rotundifoila*
Phyllanthus niruri		
Trianthema monogyna		
Portulaca oleracea		
Datura fastuosa		

Azadirachta indica
(Only very young tree)
Ficus religiosa
(Young tree growing on the wall)
Euphorbia heterophylla

One of the susceptible weeds, namely *Datura fastuosa* was examined anatomically. Transverse section of the dead stem showed that vascular bundles were completely disorganised while the parenchymatous cells of the pith remained almost unaffected. The leaves of the same plants began to shrivel on the first day of spraying and later on turned yellow and then dropped. The hard stem turned hollow and pale brown in colour.

The herbicide has also been found to be extremely effective in killing young *Peepul* trees (*Ficus religiosa*) and on *neem* (*Azadirachta indica*), which are usually found growing from the crevices of walls of buildings.

Entomology:

A survey of various grain storage systems prevalent in Allahabad district was undertaken. The existing storage methods in villages were found to be inadequate. They are mainly of four types viz., *Dholi, Kothi, Khatti* and *Kotha*. Of the systems of storage mentioned *Kotha* is considered to be the best although it requires slight improvement. A short paper on "Various Grain Storage Systems in Allahabad District" is under preparation to be published in Allahabad Farmer. While surveying various grain storage systems a pest of stored grain which has not been included in Dr. Wesley's paper on "Store Grain Pests" was noticed. It was a species of *Tenebroides* and was noticed at Gahunia village where the grain was stored in bulk in *Kotha*. Whether these insects can cause serious injury to grain is doubtful. Various opinions have been held regarding the part played by this insect in the store. Some are of the opinion that they are beneficial playing the part of a predator but experiments have proved that the grubs feed on the grain and not on any insect.

Rat Control:

In co-operation with the Extension Project and Chemistry Department some initial experiments on rat control were also done. One rodenticide "Dethmor" having .5% Warfarin was received for trial. The results on the basis of experiments conducted indicated that this chemical is very efficient, far superior to other rat poisons. It has proved good for killing rats in store houses and other buildings. The initial experiments were conducted at four places namely, the Institute Cafeteria, student Private Mess, Library and Girls Hostel. In the Cafeteria and Private Mess 26 rats were reported dead within a month. Under field conditions where considerable losses are sustained, the use of cynogas as a rodenticide is restricted since it is a deadly poisonous gas. It can be used only by persons who know how to handle it. It is probable that rodenticide such as Dethmor and Sorexa (1% Warfarin) would prove both efficient as well as easy to handle when used as a poison bait in suitable bait stations made of mud and brick located at strategic places in fields; a continuous supply of bait being maintained.

Some samples of insecticides viz., Lethane and Rhotane were also received for trial from Amrit Lal & Co., Ballard Estate, Bombay. Lethane

60 is a synthetic organic insecticide. It is a solution of *betathiocyano* ethyl esters of aliphatic fatty acids containing 10-18 carbon atoms, standardized 50% by volume with petroleum distillate capable of killing the insects by contact. It has been found to be efficient for the control of certain sucking insects such as aphids, thrips and leafhoppers. In the control of mustard aphids (*Siphocoryine indobrassicae*, Das) Lethane 60 has been recorded to be quicker in action than the commonly used tobacco decoction.

Rhothane is another synthetic insecticide. Technically it is a pure grade of dichloro-diphenyl dichloroethane. Our tests have indicated that this insecticide is very effective in killing the ticks of dogs and livestock. No further tests against agricultural pests could be conducted this year.

The paddy crop this year was severely attacked by *Gundhi* bug (*Leptocorisa varicornis*, Fbr.) all over the district. In several places the entire crop was destroyed because the insects sucked the juice from grains in milk stage. Experiments to control the insects by chemicals undertaken showed that dusting with "Grammaxane" D. 025 at the rate of 10-15 lbs. per acre was more effective than spraying with kerosene oil emulsion of D. D. T.

Extension:

This year Biology Department took greater interest in Extension work. There has been criticism that the results of researches carried out in the universities and colleges are seldom practicable, and the few that are practicable are unknown to village farmers. As an answer to this criticism, the staff of the department made regular visits to villages and gave several demonstrations on dusting and spraying. The paddy crop was seriously damaged by *Gundhi* bugs, as stated above, and farmers were shown how to use D.025 Grammaxane as a dust. In the same way spraying with tobacco decoction to control mustard aphids was also demonstrated. The department participated in all the Farmer's Fairs which were held in villages under the auspices of the Extension Project and tried to acquaint the villagers with the modern methods of controlling insect pests and diseases. Life-history of various insect pests were exhibited and their control at the proper stage was advocated. Besides these demonstrations and fairs, the staff members also prepared talks on popular agricultural topics which were broadcast from All India radio, Allahabad. A Hindi bulletin by Dr. W. K. Wesley on the control of *Gundhi* bug was published by the Extension Project. Various lectures on the control of diseases and pests were given to the trainees of short Courses in Extension Methods.

Other activities:

One of the distinguished visitors of this year was Dr. O. J. Eigsti. He gave an interesting and useful talk on hybridization of economic crops and in particular on the evolution of improved varieties of watermelons by inducing polyploidy by calchicine treatment. His talks was supplemented by lantern slides.

A review of the book 'Insects' U. S. D. A. Year Book of Agriculture 1952 was made by Dr. W. K. Wesley. He also wrote the foreword to a Hindi book on 'Krishi Hanikarak Keet Patang' by M. L. Seth (published by Desh-Sewa Mandal 54 Hewett Road, Allahabad.) The former has been published in January 1953 issue of the Allahabad Farmer.

REPORT OF THE CHEMISTRY DEPARTMENT 1952-53

By

A. P. Brooks and C. O. Das

Milk Research:

The two year research program sponsored by the Indian Council of Agricultural Research:—"To Test the Important Standard Methods for the Analysis of Milk and Milk Products, and to Determine the Standards for the Sediment Test in Milk", ended at the end of the previous report year, June 30, 1952. But the final report was written later and took much of Dr. Das' time for several months during the current month. The Voluminous typed report on the details and results was supplied to the Indian Council of Agricultucal Research, New Delhi, and to the Director, Indian Dairy Research Institute, Bangalore.

Analysis Work:

When the Milk Research scheme ended the Research Assistants left and only the teaching staff was available for handling the numerous requests from other departments for help.

The Dairy sent several samples of cream for testing. This cream was purchased from outside and was intended for butter making and there was suspicion that it might be adulterated with vegetable fats or vanaspati. Three samples were tested for Reichert Meisel and Polenski values and Saponification number. All three gave results within the normal range for pure milk fat and the suspicion of adulteration was discarded.

The Institute Cafeteria sent samples of purchased food to check on quality. Samples of bread were tested and found suitable as when freshly purchased. Samples of some biscuits were tested and some were found to contain rancid fat due to possibly long storage in dealers godowns before being sold.

Several samples of limestone and of fertilizers were tested quantitatively.

The Agronomy Department wished to make a study of the farm soils and the Extension Department wished to get information on some village soil. About 85 samples were tested with the Beckman pH meter and the pH determined on each. With the results, a soil map of the farm was prepared with the reaction of each soil being shown. This was preliminary to further tests on the plant nutrients of each soil area to be made later.

Rodent Control:

In co-operation with the Biology Department experiments on Rodent control were undertaken using the new poison developed by the University

of Wisconsin under the name of "Warfarin". This substance is available in a diluted from containing 0.5% of Warfarin mixed with 99.5% of an inert substance such as starch. For use, this diluted poison is further diluted by mixing one part of it with 19 parts of some bait which is attractive to rats and mice. Such bait has to be exposed where rats have access to it. The rat has to eat this bait on four or five successive days before death occurs. The advantage of this poison over other poisons is that is does not arouse the suspicion of the rats and they continue eating the poison bait even after they become ill. The well rats do not become suspicious and will continue to be attracted to the bait until they are destroyed. In this way, the entire colony may be eradicated in time. Other poisons usually kill a few rats at first, after which the others avoid the bait and the colony continues to thrive. This system of controlling rats has been very successful in certain Western countries in recent years. Our problem is to find out how it may be adapted to conditions in this country.

Recommendations for use in Western countries are to use a bait made up mainly of corn meal (maize *atta*) together with a certain amount of oatmeal or crushed oats. We prepared bait according to these recommendations but found that rats were not very much attracted to the corn meal and completely avoided the crushed oats which were mixed with it. However, continuous exposure of this bait for several weeks resulted in complete control of the rats which were infesting one grain godown attached to the Institute Cafeteria. It was apparent that the poison was successful although the bait was not particularly attractive to the rats especially when other grains were available as alternate source of food. These experiments are being continued in the following year with other types of bait and an attempt is to be made to see whether the system may be applied under village conditions.

REPORT OF THE HOME ECONOMICS DEPARTMENT—1952-53.

By

MISS KIMMELSHUE, MRS. AZARIAH, MRS. CHITAMBAR AND MRS. KOSHY

During the year 1952-53 there were three full-time teachers in the department. They were Mrs. Thea Chitambar who taught child Developmen' educational psychology, and sociology, and was also in charge of the nursery school; Mrs. Sucy Koshy who taught foods and nutrition and Mrs. A. Hivaulay who taught sowing. Mrs. J. Macwan assisted in the nursery school. Miss Ellen Moline, of the Ford Foundation was Head of the Department. Mrs. Glory Azariah was on leave for the year.

There were eight students in the first year and eight in the second. Mrs. Koshy, Mrs. Chitambar, and Mrs. Azariah attended the National India Home Science Association congress at Madras. Mrs. Koshy was elected Treasurer of the association.

The plans for the new Home Economics building were discussed and first drawing made.

In addition to the regular class work some of the activities of the foods and nutrition section included teaching the extension short courses and foods demonstrations in the villages and at the Farmers' Fair by the students.

In the clothing work, Mrs. A. Hivaulay taught sewing to the second year students meetings the requirements for the Intermediate examinations.

In the nursery school there were fourteen children attending, between ages of 2 and 5 years. Among the fourteen, there was one American and one English child. The hours of the nursery school were from 8 to 11 A. M. The Nursery school was used primarily for observation for the students in child development and nursery school methods. Mrs. Chitambar assisted with child development lectures to the extension short course classes. The section was also responsible for an exhibit at the Farmers' Fair.

The Home Economics Department co-operates with the Extension Department in training young women to go into the villages. Four first year students were given scholarships by the Extension Department on the condition that they would take part in the extension short course during holidays and on Saturday.

Plans are being made to broaden the training of young women for village work for 1953-54.

Helicopters Fighting Rubber Pest in Ceylon

Two helicopters are operating in Ceylon from Christmas to April to combat Oidium, a menace as dangerous to rubber as blister blight was to tea before science brought it under control. The helicopter is in many ways an ideal spraying vehicle. It can easily reach places which are difficult ar even impossible of access by land machines; it can manoeuvre in any direction, or remain poised over any particular spot, and does not damage crops or vegetation as might the wheels or tracks of land-borne equipment. A less obvious but most important advantage is that the rotor creates a downwash of air, which rebounds off the ground and carries the spray to the underside of the leaves.

FARM REPORT 1952-53

H. S. Azariah And A. N. Singh

The Institute farm is directed by a Policy Committee of which the Principal is the chairman. Cropping plans are made to provide mainly, fodder for the Dairy herd of nearly 300 head. Improved seeds for the department of Agriculture are also produced in the rabi season. The Farm Manager executes the policy and approved plan of the Farm Policy Committee.

Until January 1953, the farm was under the direct supervision of Mr. G. D. Singh, the Farm Manager, when Mr. Azariah was appointed officiating Farm Manager and Mr. A. N. Singh as Assistant Farm Manager. The services of the latter was transferred to the farm early in February.

Weather and Rains:

The first shower of 0.17 inchee came on June 4, followed by an extremely hot fortnight which registered the highest temperature 118 F on June 10, 1952. Regular monsoons broke out on June 21, and continued satisfactorily allowing fine days, now and then, for seed-bed preparation. Rains were even in the month of July also. There was a break of 10 days in early August, but the heavier and well spread out rains followed in the latter part of the month. September also recorded 4.13 inches of rain with several fine days, raining every tenth day or so. October was dry and cloudy, with the exception of a mild shower on the 8th. Again there was no flood this year. The temperature went down to 70 F on October 14 and further fell by 13 degrees towards the end of the month. November and December were cool months as usual, with the minimum temperature of 40 degrees in the third week of December, and with cloudy weather during Christmas week. There was a mild shower in the middle of January and also in the first week of February 1953. After mid-February the weather grew warm steadily and winter crops were ready for harvesting by the middle of March.

Farm:

The purpose of the farm is not to provide a large income towards the running of the Institute. It is essentially a college farm, for experimentation and demonstration. It provides however, valuable data for farm management studies.

Crop Data:

Total area under cultivation:

Under farm	...	294.42 acres
Agron. Education	...	10.5 acres
Orchards	...	24.6 acres

Total crop area excluding fallows:

Under farm ... 508.97 acres

Area under different crops:

Kharif fodder			*Kharif farm crops*		
Maize	... 30.9		Maize seed	... 5.6	
Juar	... 84.36		Vegetables	... 9.8	
Cowpeas	... 54.60		Cowpeas seed	... 3.0	
Napier	... 15.95		*Sanai* seed	... 2.2	
Para grass	... 0.3		*Sanai* gm	... 9.5	
Sunflower	... 0.5		*Dhaincha*	... 20.0	
Lucerne and Sunflower	... 6.0		Paddy	... 1.5	
Bajra	... 2 5		*Mung*	... 2.0	
			Juar seed	... 28.54	
Total	... 195.11	70%	Total	82.14	33%

Rabi

Lucerne	... 4.0		Wheat	... 72.82	
Sunflower and Oats	... 13.0		Barley	... 51.2	
Para grass	... 0.3		*Berra*	... 14.1	
Napier	... 15.95		Gram	... 5.5	
			Potato	... 8.6	
			Arhar	... 25.85	
			Peas	... 2.39	
			Vegetables	... 9.8	
Tota l	... 35.95	15%	Total	... 190.26	
			Misc.	... 6.51	
				196.77	85%

Most of the farm land is intensively cropped, index of intensity being 173. It has tended to fall in fertility due to intensive cropping and insufficient manure. During the year, the farm received 973 cart loads of farmyard manure which is hardly sufficient for 40 acres. Oil cakes and some fertilizers were also used. Increases in yield can be made with careful crop planning, liberal use of compost and fertilizers.

Yield:

The yield of fodder crops were average. Among grain crops, the yield of wheat and barley varied from 5 to 25 maunds and 5 to 30 maunds per acre respectively.

The Institute supplied 450 maunds of first quality wheat and 480 maunds of barley and some peas to the Department of Agriculture for seed purposes. The Department of Agriculture pays a premium on good

quality seed wheat, but since they take delivery at a time when the market is low, it is not encouraging to supply seed to the government.

Cost Data:

Total expenditure on the farm	... Rs. 123,039/-
Total Income	... Rs. 136,301/-
Plus Balance	... Rs. 13,262/-

Some of the major expenditure items:

Supervisory and Clerical staff	... Rs. 11,160/-
Bullock maintenance (60 animals)	... Rs, 43,626/-
Man labour cost 35,995 men days	... Rs. 52,211/-
Cart maintenance	... Rs. 2,761/-
Implement maintenance	... Rs. 3,989/-
Harvesting by combine app. 50 acres	... Rs. 701/-
Threshing of grain crops by thresher	... Rs. 1,043/-
Irrigation cost Tube-well and sewage	... Rs. 7,952/-
Farmyard manure (973 carts) hauling only	... Rs. 5,580/-

The cost figures seems to indicate that it would be profitable to make careful studies on relative costs of bullock power and tractor for farms of this size. To maintain 52 bullocks and 8 buffaloes, it cost Rs. 43,626/-. This is a large sum. Although a pair of bullocks had been controlling 15 to 18 crop acres, they have not been able to cope with timeliness of operations.

High wages would again call for careful study and adoption of labour saving devices. The number of men employed on the farm daily for the year was 103. Approximately 9 men were on the pay roll of the farm, who were used by other departments. The total wage bill was Rs. 52,211/-. To this must be added supervision charges of Rs. 11,160/-.

Small Amounts of Chemical Products Improve Nutrition Quality:—Man's years of study of the chemical nature of food products and of the nature of the nutrients required by the body are now beginning to pay dividends at an increasing rate. Years ago he began to understand that proteins, fats and carbohydrates were needed and he thought that he had come to high understanding of food and health needs. But the discovery of vitamins made him realize that the matter was extremely complex and delicately balanced. Now he is finding increasingly that deficiencies, which can be corrected by mere traces of the right chemical material, can cause serious imbalances and damage. Also he is seeing ample demonstration that merely having enough to eat does not keep a body running right. For example, there are requirements not only for sufficient protein, but also for certain kinds of protein. However, protein quality deficiency can be corrected by supplementation with a small amount of certain chemically pure amino acids or with other foods which are sources of the necessary acids.

REPORT OF THE AGRICULTURAL ECONOMICS DEPARTMENT FOR

1952-53

H. S. Azariah and A. D. Wycliffe

A new post of a Research Assistant was crected in the department this year and this has helped considerably. Mr. A. D. Wycliffe was appointed to this post in the last week of August.

It was contended by some that there was a co-relation between the amount of green fodder supplied by the Institute farm and the amount of milk produced by the dairy cows. A study was undertaken therefore, to find out if there was any co-relation between the amount of green fodder supplied to the Animal Husbandry department and the milk yield. Data for the last three years were taken and no significant relationship was obtained. However, this study helped in modifying the cropping scheme for the next year so as to include several types of fodder. It was clear from this study that perhaps what was more important with respect to milk yield was the *type* of fodder that was available at *different times* of the year.

The study on the cost of production of various crops grown on the Institute farm was continued. This included a study of labour distribution as well as return per day of labour on various farm enterprises.

Another comparative study was made on bullock power on the Institute farm. The cost of utilizing of bullock power for the years 1938-40 was compared with that for 1949-52. It was noticed that there was a decline in the efficiency of employment of bullock power; and that the cost had increased nearly four times.

A significant work of the department this year, was to make a special effort to keep in touch with rural problems through the Extension Project. Again, Mr. Wycliffe was the contact man for the deparsment. He attended several Circle Meetings of the Gaon Sathis and kept the department informed of the problems that were brought by the Gaon Sathis to the Circle Meetings.

Rat's Service in the Study of Nutrition:—Most people affected by agricultural and food chemistry probably consider the rat only an enemy or a competitor in the fight for food. But in laboratories throughout the world thousands of rats are depended upon to guide the course of research work. What is the effect of a given amino acid imbalance in the diet? Studies on the rat will serve as a guide in the approach to human testing. On the other hand the producers of agricultural chemicals work constantly to produce more effective rodenticides. In fact the very potent rat killer ANTU was discovered by a research worker who observed that humans found that alpha naphthyl urea was either virtually tasteless or extremely unpleasant to taste. Curious to learn of such a variation in reactions existed in animals, he fed it to rats. They all died, and a new rat poison, safe to humans was found.

The rat is deeply involved in man's efforts to feed himself better.

REPORT OF THE DEPARTMENT OF HORTICULTURE,

1952-53

W. B. HAYES, T. DEAN, AND V. N. DUBE

The direct sale of fruits, mainly wholesale, was continued, the major crop being papayas. There were 1,026 bearing trees, all with their second crop, and of these 36 died without any considerable production. The total receipts from papayas, after deducting expenses in Delhi, was Rs, 12,026, or an average of Rs. 12-2-0 per bearing plant, or about Rs. 6,000 per acre. About one third of this amount was used in guarding, harvesting (including production records), and shipping to the market. This leaves about Rs. 4,000 per acre to cover the cost of production and profit.

This year most of the papayas were sold in Delhi as the price there was better than in Calcutta and the demand was greater than we could meet. The wholesale rate in Allahabad was only Rs. 5 to 8 a maund. The price in Delhi was slightly higher than the year before, starting in November at about Rs. 26 to 30 a maund, and running from Rs. 16 to 24 during the rest of the season. Still earlier in the season, in October, Delhi prices are sometimes Rs. 35 to 48, a maund for the very limited supply. These figures suggest the desirability of securing as early a crop as possible. As the older trees ripen some fruit earlier than those bearing their first crop, the advantage of taking good care of the older trees and keeping them in good health and bearing is obvious.

In order to find at what seasons papaya seed would germinate in the open at Allahabad, seed was planted each month from June to March with the following results:

Month		Time required for germination	Germination
June	...	15 days	80%
July	...	10 ,,	100%
August	...	7 ,,	100%
September	...	15 ,,	80%
October	...	45 ,,	10%
November-March	...	No germination.	

During February and March an attempt was made to secure germination of papaya seed by using fresh seed and seed which had been dried for 1, 2, 3, or 4 weeks, and by soaking it in cool or warm water, or in water containing cow dung. No germination resulted.

During the rainy season papayas were planted on about 4 acres of rather poor, uneven soil, using the contour system. Although this was laid out rather roughly, satisfactory irrigation was possible except for two or three plants. The cost of grading the land so that straight rows could be used would have been quite large. In most of this area the plants were

set three at a place about 10 ft. apart, but small areas were planted at 5 ft. spacing and with single plants 3 ft. apart. Where three are planted at a place, only one is left after flowering and the percentage of female plants is fairly satisfactory. As this land was no better than that which two years earlier had proved incapable of producing an economic crop, each plant was given 2 lb. of ammonium sulphate in addttion to some farmyard manure. The leaves became dark green and the plants grew satisfactorily. Lest the plants become too tall, the fertilizer was not given until November. Some of the plants have set fruit as low as two feet from the ground.

Local varieties of figs were again sprayed with paradichlorophenoxyacetic acid, applied in two dilutions, one on one third of each tree, while one third was sprayed with water. Only the leaves sprayed with the acid curled, expecially the young ones. There was no observable difference in the fruiting as a result of treatment.

The peach trees imported from California, where they had been bred to withstand mild winters, again suffered from delayed foliation. Howover, they continued to grow fairly well. The Indian variety which set some fruit the year before when less than two years old, began flowering about January 1, and set a good crop, largely harvested by the birds. The remaining imported white sapote died, but fortunately the graft which had been made from it is growing well, as are seedlings of a closely related species, *Casimiroa tetrameria*.

Preliminary work in guava breeding was begun. Bagged flowers set fruit, confirming the fact that self-fecundation is possible in this species, and that insects are not required for pollination, although they may help. Out of 40 crosses between red and white-fleshed varieties, only two fruits were obtained. The seeds of these have been planted and have germinated. The seedlings will be planted in the orchard for trial.

Evidence continues to accumulate of the ability of fruit trees to use more nitrogen than is supplied by our soils with the addition of a fair share of the farmyard manure produced on the farm. The addition of 2 lb. of ammonium sulphate to each alternate two-year-old tangelo plant in the orchard resulted in increased growth with leaves of a deeper green, but the difference was apparent only for about two months.

Insect pests continue to be a problem. Among the most common on the citrus trees is the lemon butterfly which causes important damage in the nursery and on young trees. Spraying with Gueserol 550 (a DDT insecticide) was only partially effective, and hand picking continued to be necessary. Scale insects, aphids, and some other pests are ordinarily held under control by parasites and predators unless protected by ants. Therefore measures have been taken to eliminate the ants. On certain trees there were large numbers of a black ant, a species of *Formica*, and these disappeared about 15 days after placing on some of the branches shallow pans containing a solution of sodium arsenite and sugar. In the case of the red ant, *Oecephylla smaragdina*, which makes nests by webbing together leaves of citrus and other trees, and which, because of its severe bite is a nuisance, breaking open the nests and dusting them with gammexane proved entirely successful.

For additions to the variety collection, the Institute is again indebted to the Fruit Research Station, Saharanpur, for the following plants : Grapes : Golden Yellow, Early White, Early Yellow, and Mothia, of which only the last two survived; Citrus : trifoliate orange, Hill orange, Mikan Satsuma, and Nagami and Marumi kumquats, of which the last died; Peaches : Double Flowering, Dehra Dun No. 2, and Saharanpur Nos. 3 and 5; and Banana : Guthlahien, Muthali, Ceylon, and Rajali. The plant of *Citrus indica* which was secured the previous year from Burnihat, Assam, but died, was replaced by another plant which also has not grown well.

Little experimental work was done in fruit products, although the usual amount was manufactured to meet the local demand. Further experimental work on the manufacture of vinegar from sugarcane juice was done.

An agricultural map of India is planned. Pictorial representation often conveys more vividly the meaning of figures than is possible for the naked eye to glean from a mass of data. An Indian Agricultural Atlas brought out recently by the Directorate of Economics and Statistics, Ministry of Food and Agriculture seeks to present all important agro-economic data relating to India in the form of maps and diagrams.

Bilaspur is the smallest State in India and Madhya Pradesh is the largest in area; the total population of U. P. is larger than that of any other State but the density of population is the highest in Travancore-Cochin; foodgrains occupy nearly three-fourths of the sown area and of the net cultivated area, less than one-fifth is irrigated.

Rice is the largest irrigated crop; and the area under it is largest in Bihar, though Madras ranks first in production; Bombay has the largest area and production of jowar but is fifth in its yield per acre: U. P. ranks first in area and production of wheat but is second to Punjab and Pepsu in yield per acre; though cotton is grown in a large number of States, its yield per acre is highest in Pepsu, Rajasthan and Punjab.

These are some of the important facts represented in the Indian Agricultural Atlas. World maps have also been given to illustrate the position India occupies in the world in respect of important agricultural crops.

REPORT OF THE EXTENSION DEPARTMENT, 1952-53

By T. A. Koshy and A.N. Singh

One of the activities of the Extension Department until last year was rural extension work in the villages around the Institute. With the establishment of the three-year Extension Project a year ago, this work has been temporarily merged with that of the Project. Other activities were continued as before. It has been the resposibility of this department to arrange for conducting the visitors around the Institute. This year there was a great increase in the number of visitors, who range from the village farmers to Agricultural Experts of the Technical Co-operation Mission and The Food and Agriculture Organization of the United Nations. Mr. M. C. Newton spent most of his time on this job.

A second programme which was continued was the offering of short courses on rural development and land utilization to the students of the Leonard Theological College, Jabalpur, and the final year students of B.Sc. (Euthenics) class of the Isabella Thoburn College, Lucknow. Twenty-three students attended the former and seven the latter.

The third aspect of the work of the Extension Department is the supervision of the two Agricultural Extension Advisers assigned to the North India Synodical Board and the Disciples Mission in Madhya Pradesh. These advisers who live in rural areas assigned by the Mission, work with rural pastors, preachers, and rural Christian leaders in the various activities of rural development. Mr. W. R. Chester who was working at Shikohabad was loaned to the American Presbyterian Mission in 1952-53 to be the officiating Manager of the Etah Poultry Farm during the absence of its Manager. Mr. Jangjit Singh was then assigned to Shikohabad. He spent a good deal of his time getting acquainted with the people in the area and studying their problems. As Mr. Chester continued to give some help to Mr. Singh, the 12 point programme of better seed, chickens, goats, manure, extension education, health, literacy, etc., was continued. The improved seed introduced a few years ago was in great demand in the district. The distribution of vegetable seedlings was done as in previous years. Leather curing co-operative at Nagla Mandhata has shown a revival. The four curing tanks built at the village are continuously in use.

Mr. A. N. Singh who has been working at Takhatpur in the Disciples Mission area in Madhya Pradesh for several years, has established an Extension Centre there, where production of nursery stock, poultry raising, crop trials, etc., are carried out. The Centre distributed over 3 tons of improved rice seed in 30 villages. An inexpensive chicken pen has been designed at the Centre and popularised in the area. In September last there was an unprecedented attack by Ghundhi bugs on paddy plants in Takhatpur area. In co-operation with the Government and local bodies the Extension Adviser carried out a timely and very effective campaign to control these insects. Two tons of Gammexene was quickly procured from Calcutta and farmers purchased the dust most willingly. One difficulty

was the lack of suitable dusters. To overcome this, the Extension Adviser improvised a "duster" by fixing muslin to a wooden frame with two handles at each end, somewhat like a sieve used by building crew to sift sand. The insecticide dust is placed on the muslin and the "duster" is carried along the field by a man, giving a gentle jerk to the duster as he walks along. Acres of paddy were thus dusted and a serious invasion by the pest which would have reduced the rice yield to almost nothing has been completely eliminated. The campaign was so successful that the District Magistrate and several high officials visited the area and commended very highly the resourcefulness and promptness of Mr. Singh.

Mr. Singh was transferred to the headquarters at the Institute in February 1953 as Assistant Farm Manager. In his place Mr. S. K. Sadhu was appointed. He is carrying on the work under the guidance of Mr. Singh and Mr. R. A. Robinson.

Visits by members of the Extension Department staff to various missions which have asked for advice on agricultural and rural problems continued. Mr. J. G. Short who was in charge of this work visited 50 stations during the year, and gave advice on a number of agricultural matters.

Training of Chief Social Education Organisers : At the request of the Community Projects Administration of the Government of India, the Agricultural Institute agreed to train the Chief Social Education Organisers of the Community Projects throughout India. This course was offered under the auspices of the Extension Department, with the Head of the Department as its Director. 23 men and 6 women were trained in the first batch and 20 men and 10 women were trained in the second batch which began its five-month training in July 1953. It is very gratifying to note that the Community Projects Administration has asked the Institute to offer this training to one of the important functionaries of the Community Development Projects.

There is a general awakening in the country to the problems and needs of the village people. The opportunity for a sound extension service is very great. This department which was established about seven years ago welcomes this opportunity for service and is eager to share with others of similar interest its experience, methods and materials, in order to usher in a new era for the rural people of this great country.

REPORT OF THE EXTENSION PROJECT FOR 1952-53

By T. A. Koshy and J. B. Chitambar

The organization and establishment of the three-year Extension Project was reported last year. The scheme, which is financed by the Ford Foundation, consists of three sections as follows:—

1. Extension pilot project
2. Training in extension methods.
3. Production of extension materials.

In this report, a summary of the activities of each section is given. A detailed report is being published separately and will be available from the Project office to those who are interested.

Extension Pilot Project

In the 400 village of the Meja and Karchana tehsils of Allahabad District where this experiment in agricultural extension is being carried out, the project is known as "Jumna-par Punarnirman." Forty-three village workers who were selected after a pre-selection course and appointed in May 1952 were in the following five categories based on their educational qualification and training. As the work progressed twelve more were selected and after a short training were posted. At the end of the first year the numbers of gaon sathis were as follows:—

High school passed 10
Intermediate 9
Graduates 10
" Constructive " 8
Couples (Husband and wife working as a team) 9

They have been assigned to the four circles (corresponding to blocks of the Community Development Projects) in such a way that each circle has at least two of each kind. As far as the workers are concerned, the Project expects to compare the performance of different types of gaon sathis in accomplishing targets and changing the attitudes of people and to see if there is any correlation between accomplishment and educational background.

In the second place, the project expects to test the effectiveness of four method of approach, each of which receives major emphasis in one of the four circles. These methods are literacy, occupation, " felt needs " and whole family.

Targets

The selection of targets is largely influenced by the two main agricultural seasons, *kharif* (rainy season) and *rabi* (winter season) and is

arrived at through discussions with gaon sathis in the light of their experience in the field. Thus, from about February and August of each year, the matter of the next season's targets occupies a good deal of the time spent by gaon-sathis at general meetings. A sample of the targets is given below:—

Targets for the rabi season—1952-53

S. No.	*Targets*	*Size of minimum targets in the four circles*			
		Sirsa	*Karchana*	*Iradatganj*	*Jari*
1.	Teaching of adult illiterates daily	1	1	1	3 illiterates
2.	Training literates in Laubach method & getting them to teach groups of illiterates	3	3	3	5 trainees & groups
3.	Opening of reading rooms	1	1	1	1 reading room
4.	Smokeless *chulha* (stove)	1	3	1	1 *chulha*
5.	Small-pox vaccination	100	100	100	100 villagers
6.	Sanitary latrine	1	3	1	1 latrine
7.	Sewing & knitting	10	5	2	2 families
8.	Soak Pit	2	5	2	2 soakpits
9.	Storage of seed	15	3	9	3 farmers
10.	Sowing of improved seed.				
	Wheat IP 4 or C 15	5	1	3	1 demonstration
	Barley C 251	5	1	3	1 ,,
	Gram T 87	5	1	3	1 ,,
11.	Selection of pure seed for next year's crop (roguing)	15	3	9	3 farmers
12.	Making of compost	3	3	10	3 ,,
13.	Improved pultry or pig raising	3	3	5	3 ,,
14.	Sowing of green fodder	2	2	6	2 ,,
15.	Improved irrigation, well boring	6	3	5	3 wells
	or repair or digging of old tanks	1	1	1	1 tank
	or making of wells	2	1	2	1 well
16.	Growing of fruit trees	10	5	5	5 farmers
17.	Group demonstration—Ease of learning (fortnightly)	1	1	1	3 demonstrations
18.	Organising children's or youth games groups	2	5	5	3 groups
19.	Felt need (worked out by each *gaon sathi*—Individual target	1	1	1	1 felt need
20.	Hot weather cultivation	3	3	9	3 farmers.

Methods used by gaon sathis:—The basic method used by gaon sathis in their work is approach through friendship. Their very name ' gaon sathi,' which means " village companion ", emphasises this approch. It is correct to say that " friendship " is the very foundation of village work in the Jumna-par Punarnirman. It is a basic principle that when one is trying to get rural people to transform their whole life, no change is really worthwhile unless it comes from the people themselves. Having established a foundation of friendship the gaon sathi's next step is to present factual information to the villager in ways easily understandable by him, such as audio-visual aids, and then showing him how he can solve the problems through the use of the information or skill, but always leaving it up to the villager himself to make the change. The gaon sathi lives in one of the 8 to 10 villages assigned to him and so he is able to have more opportunity for conversation and contact with village

people. In addition to this, the project also uses radio as a means of mass education. A fifteen-minute programme is broadcast each evening from the All-India Radio, Allahabad, as a part of the Gram Panchayat programme. The programme is produced and recorded at the project headquarters or in the villages, using as far as posible village talent. The main feature of the programme is of course entertainment, but it is also used for communicating ideas and information about improvement in agriculture and other target topics on which the gaon sathis are working. Reports indicate that the daily listeners at each of the 67 radio sets installed by the project in the villages range from 15 to 75. The plans are to install about 80 more community listening sets as soon as the sets, which are on order, are received. The language used in this programme is " *dehati* " the local dialect of the area. While discussing the methods which are used in the project, it might be well to mention also the methods that are not used. These are:

1. *Force or compulsion.* The gaon sathi hasno way of forcing the villagers to accept a change. Even if he had any method of forcing, he would not use it, as he and the project do not believe in change brought about by force. For any change to be permanent it must come from a free decision of the person concerned, based on a correct understanding of the advantages and disadvantages of the changed practice. Even at the risk of being criticised for using a " slow method ", this fundamental principle in extension is strictly adhered to. From the past year's experience, it can be said that this is actually the strength of our programme. It has made the acceptance of the gaon sathis by the village much easier.

2. *Free gifts.* The project does not give any material aid to the villagers. Teaching aids such as booklets, posters, newspapers and radio sets are provided free of cost. Apart from these nothing is given by the project. The gaon sathis help the villagers to realise their own strength and they show how it can be used to solve many of their problems.

3. *Serving as a supply agency.* As an educational programme in rural development, the project has not undertaken the responsibility for the supply line. Rather, an effort in made to strengthen the existing supply and service agencies, such as seed stores and village merchants. By enabling access to scientific knowledge, it is hoped to create in the villages a demand for improved occupational techniques, tools, and services. It is hoped that in the course of time the channels of supply and service will be able to cope with increased demand, thus completing the step forward.

Following are some of the Government supply and service agencies that exist in the project area.

1. Government seed stores. (Agricultural Department)
2. Co-operative seed stores and credit societies.
3. Veterinary hospitals, veterinary doctors, and stockmen.
4. Sanitary inspector (Public Health)
5. Plant protection service.

The co-ordination of the educational activities of the project with these agencies has presented certain difficulties. At the district level there has been full co-operation, but in actual practice in the field the supply has not caught up with the effective demand. Apart from administrative bottlenecks which, it is felt, will be eradicated in time, one is led to the conclusion that unless the field staff connected with these agencies consider themselves a part of the village community they will not be able to pull their weight in the regeneration of village life from within.

The gaon sathi can be an excellent leavening force in the village, touching not only one section but the village community as a whole, including farmers, tradesmen, Government representatives, members of other service agencies, and those engaged in caste occupations.

Better co-ordination of target efforts with those of Government is increasingly being achieved by the help and interest shown by the District Planning Officer.

Developing the Villager's own Resources:—While encouraging the villagers to make full use of Government facilities the project also tries to instill in the villagers the will to take advantage of their own resources and to develop their resources to solve their problems. There are rich stores of resources which lie untapped in the villages. These resources are both natural and man-made. Both of these can be used to develop village life.

We have again and again met with instances of knowledge and technical skill that have somehow been isolated, which if spread to other project areas would go far in solving problems. An example of this is the *charas*, with a delivery tube, for irrigation from wells in certain other areas of Uttar Pradesh. The delivery tube is unknown in the project areas and its absence calls for an additional man to perform the function of emptying the contents of the *charas* when it is drawn to the surface of the well.

It is the attempt on the part of the project here to strengthen and build up supply lines in the village itself. We have done this in the case of supply of Gammexane, Paludrine, agricultural implements (through local village merchants), the teaching of illiterates in the area by training local village literates in adult literacy methods, and in the training of local village masons in the construction of smokeless stoves etc., etc.

In-service Training of Gaon Sathis:—The gaon sathis who were selected at the beginning of the project were given two weeks of preliminary training. The primary purpose of this training was to make them think more about their own attitude towards their work and towards the villagers. In the second place, it was used to plan jointly the activities of the project for the first season and the subsequent fixing of targets for the same period. A very fruitful outcome of this training was the formulation of the Gaon Sathis' creed.

For the first six months of the project, the gaon-sathis were brought to the Institute every week for two days of in-service training. This consisted of the following:

1. Training in subject matter related to the targets, both in class-room as well as practical work in the fields.

2. Understanding the basic principles of extension and practice in the use of extension methods and techniques.

3. Contact with government officers such as the District Planning Officer; District Agricultural, Panchayat, Co-operative and Medical Officers; and a knowledge of the supplies and services available from the government and the correct procedure for getting them.

4. Training in reporting each day's work. Special effort was made to make the gaon sathis realize the importance of accuracy in reporting, especially in view of the experimental nature of the project.

After the first six months, the gaon sathis were brought to the headquarters every fortnight for three days training, thus giving them more time in villages.

Contacts with Gaon-Sathis and the villages:—Administrative and other staff at the headquarters maintained contact with gaon-sathis and villagers in the following ways.

1. Gaon sathis coming to the headquarters as described above.

2. Through circle meetings in the villages. These were held in each circle twice a month and were attended by the gaon-sathis of the particular circle and the villagers who cared to attend. Invitations to these meetings were also sent to the staff of the departments of the Institute, the District staff of the government and any others interested. Officially, this was the only way the numerous visitors were taken to the project villages.

3. Through individual visits to gaon sathis by the headquarter staff. There visits are made as often as possible and have been a source of guidance and encouragement to the gaon sathis.

4. Through fortnightly 24 hour visits to villages by members of the headquarters staff. It has been the practice during the latter part of the first year for each member of the headquarters staff (administrative and others, like artists, photographers, radio personnel, etc.,) to spend a 24-hour period in the village with a gaon sathi. These were arranged usually from Monday noon to Tuesday noon every other week. This practice helped the headquarters staff to learn more about the village, the problems faced by the gaon sathis, and to see some of the changed practices in the village. The staff members who went on such visits were instructed to observe the gaon sathi's work and not to make any recommendations to the villagers directly or to correct the gaon-sathi. They were encouraged to write brief reports of their visits and send these to their directors.

Gaon Sathis Bring Changes:—There has been an awakening among villagers in terms of their needs and of their strength. The recommendations which the gaon sathi has to offer to the villagers are being more readily accepted. During the first *kharif* season a number of libraries were opened as a result of the general interest created in literacy. A few youth clubs were also organised by the villagers themselves. A few small projects requiring corporate activity were undertaken, such as construction of bundhs, small roads, etc.

Requests have been received from villages not in the project area for posting a gaon sathi in their village. A similar request came from a village in the Mirzapur district. It has also been noticed that when a gaon sathi has been withdrawn from any village, representations have been made by the villagers for his return. The gaon sathi is increasingly becoming an essential part of the village community, as more and more villagers come to him for consultation and advice. An important change has taken place when the villager comes to the gaon sathi for advice instead of the gaon sathi going to him.

There has also been considerable progress in work among women. We had the privilege of having on our staff an experienced woman extension worker whose aid was sought by gaon sathis for work among women. Small projects for the women have been started in the villages, which are looked after by the gaon sathis.

By far the greatest change during the first year, however, has been that which has taken place in the gaon sathis themselves. This change has been more evident to the people outside the project than to the project staff. Often remarks such as, "He is not the same man" and "Something has happened to him," reach our ears. This has been a great change and the most important.

Change in Gaon Sathi's Outlook Important:—During the first year in any rural development project the type of changes to be aimed at should in general be has follows:—

1. Reorientation of the gaon sathis' thinking and attitude towards extension work.

2. A realization by the gaon sathi of the strength that exists in the village.

3. A realization by the gaon sathi of his own ability, his strengths and weaknesses with relation to the job in hand.

4. A realization by the gaon sathi of the importance of accurate and truthful reporting, so that more reliance can be given to his records.

Practically all of the gaon sathis who are working with the Jumnapar Punarnirman have gone through the above stages during the first year. We now look to the next few years with greater confidence because many of our difficulties have been solved. Other divisions of the project have become established so that a greater supply of extension material is available for gaon sathis' use. We have this confidence chiefly because

a year in the field has made us alive to a rich store of strength in the village, and because there has been an increasing realization on the part of village people, themselves of the strengths and resources that can be used to solve their problems and meet their need.

Rural India is on the move. Social change is a fact. The direction of the change comes to us rural workers as a challenge. Jamunapar Punarnirman take up this challenge with renewed zeal and enthusiasm in its attempt to serve more fully the rural people of our country.

Training in Extension Methods

This section of the project offers three types of training as follows :

1. For the gaon-sathis who come every three weeks for three-days training.
2. For regular students of the Institute who volunteered to attend classes of extension course during holidays.
3. For outside persons who are either engaged in agricultural extension work or in some other kind of rural development works.

The training for the gaon sathis has already been discused in the report of the extension pilot project. For the short course in extension methods, a syllabus consisting of the following subjects has been prepared and approved by the Institute staff.

PART A

I. COMMUNITY PROJECTS
II. EXTENSION SERVICE
III. RURAL LIFE
IV. EXTENSION METHODS
V. RESEARCH METHODS
VI. PROGRAM BUILDING
VII. ORGANISATIONAL ACTIVITIES
VIII. ANALYSIS OF PROJECTS

PART B

I. SOILS
II. CROPS
III. DISEASES AND PESTS
IV. AGRICULTURAL ENGINEERINC
V. ANIMAL HUSBANDRY AND DAIRYING
VI. HORTICULTURE

PART C

I. PUBLIC HEALTH AND SANITATION
II. ADULT LITERACY
III. RURAL RECREATION
IV. CHILD CARE
V. FOODS AND NUTRITION
IV. HOME IMPROVEMENT

Information regarding the Extension short course was widely publicised. As a result of this, over 300 applications were received for the 60 seats in the Extension short course for Institute students. After careful testing and interview of the candidates, 60 were selected for the short course. Of these, 50 received scholarship to cover their expenses for study at the Institute. Classes were held during 26 holidays. In addition to the regular classes, each student was assigned a village near the Institute in which to work. The students were required to spend at least one evening every week in the villages assigned to them and one evening and night every two weeks. The students were not expected to engage actively in extension work as they were still under training. They spent most of their time in getting acquainted with village work, village life, village problems and obtaining general understanding of the problems of an extension worker. Each student was also required to complete a small project in the village. Some of the Projects done by the students last year are as follows :

1. Occupations and income of the villagers of Fateh Mahmoodpur.
2. Health survey of Gangia Village
3. A study of the attitude of the people towards education of their children and the facilities available to the children of Indelpore Village No. 2
4. Survey of the subsidary industries existing in Gangia Village
5. Effect of employing centres on agriculture
6. A study of sanitation in Markani Village.

Fifteen students of B. Sc. (Ag.) final year and 2 students of B. Sc. (Ag. Eng.) final year classes were among the 60 who received the training. Almost all of them are now doing work connected with rural developent. Of the remaining, 22 are now in the second year one month course which is of an advanced nature.

Training for Outsiders :—A one month short course for outsiders was also offered during the year. The enrollment for this course is as follows :—

I.	Course	26 students
II.	Course	39
III.	Course	31
IV.	Course	29
V.	Course	27
VI.	Course	28
	Total	180 students.

These student came from all parts of India. Nineteen of them were women. Diplomas have been awarded to those who have successfully completed the course.

Production of Extension Materials

In the experience of the staff of the extension department of the Allahabad Agricultural Institute, the lack of useful audio-visual material for extension work was keenly felt. Although a number of charts, posters, and other materials have been prepared in various parts of the country they are not very useful in the three year extension project of the Institute. Because of this, it was neccessary for the project to produce its own materials which are based on sound extension principles and the ability of the average villager to grasp the ideas depicted in such materials. The materials production section of the project was started in July 1952.

Production melhod :—After the targets are fixed, the gaon sathis suggest the kind of materials they need for their work. They also suggest ways of illustrating the topics. Where scripts are needed, as in the case of flashcards and filmstrips, the ideas are usually supplied by the gaon sathis. Scripts are prepared, and each subject is then considered by the materials production committee of the project which has on it individuals trained in the fields of agriculture, animal husbandry, home economics, public health, etc. Also included is the studio staff, consisting of artists, photographer and editor. These weekly meetings are attended by directors of the sections as well. After the discussion on each topic, one effective way of illustrating the topic is decided upon by the committee and an artist is asked to prepare a rough drawing. This is discussed again by the same committee and changes made if necessary. The revised drawing is then shown to the gaon sathis for their criticisms and suggestions. This is done to see if the idea is easily conveyed and whether the picture is easily understandable. After this the material goes into production.

This section of the project strives to produce materials for each season for the work of the gaon sathis in their respective villages. On this basis it has produced the following materials in 1952-53.

Posters :—Twenty-one black and white posters have been produced dealing with the following :

Agriculture topics	8
Animal husbandry	2
Public health	4
Home and family	2
Plant protection	2
Literary	1
Others	2

Flashcards :—India Village Service has been producing flashcards on various topics for a number of years. Because of the type of drawing used, these are popularly known as the "Jet Series". When the gaon sathis used them in their villages the comments of the village audiences indicated that they are not used to this particular style of illustration and

therefore had difficulty in followiag the stories. To try to overcome this the project artists have used outline drawings for the flashcards which seem to be more effective in this area. Tests are being conducted with three types of drawings to determine which type is most effective. Flashcard sets have been produced on the following subjects :

Agriculture	1
Home and family	1
Public health	1

Filmstrips :—Here again the ideas are usually supplied by the gaon sathis. Then a shooting script is prepared and the photographs are taken, usually in the villages, using village people as subjects. These pictures are assembled in the proper sequence and the materials production committee reviews them, paying particular attention to the composition of the pictures, the correctness of sequence, the suitability of captions and the general appearance of the proposed filmstrip. After necessary changes or corrections a master negative is prepared from which multiple copies can be made by a commercial photographic studio. Because of the difficulty of obtaining the necessary equipment and darkroom facilities actual production of filmstrips did not start until September, 1953.

Booklets :—In addition to the above media, which are aimed at a village audience that is largely illiterate, another medium, booklets, is utilized by the project. Obviously, it is those who can read who benefit most from this medium. Nevertheless booklets do help the illiterate person as well, the contents being read out to him by a gaon sathi or by another villager who can read.

The materials production section has published a series of 22 booklets in Hindi dealing with the following :

Agricultural topics	10
Cattle diseases	1
Public health	4
Plant protection	1
Literacy	1
Others	5

These booklets have been written by the Agricultural Institute staff in close co-operation with the project staff and gaon sathis.

Hand puppets :—Puppetry is an age-old form of entertainment in the rural areas. Because of the tremendous popularity of this medium the project has tried to make use of puppet shows as a means of education. As hand puppets are easy to make and operate they are being tried. A script is prepared for the story that is to be told and puppets are made according to the characters in the story. Each story is based on some problem faced by the villages and its solution. The advantages of hand puppets are that they are easy to make, inexpensive, and can be successfully operated after comparatively little training. The ones used in the project have heads made of papier mache and are dressed in bright, gay

coloured clothes. The stage for the puppet show is portable and the curtains are attractively made. The narrator or the narrators also play some musical instruments and sing songs. These puppet shows have become very popular in the villages of the project area and are proving of increasing usefulnes in mass education.

All materials produced for the project are priced and may be purchased by organisations and individuals outside the project. A price list is available on request from the materials production section.

Training in Literacy

Towards the beginning of 1952, Dr. Frank C. Laubach, the famous world expert on adult literacy was making plans to set up a training centre for literacy workers. He offered to establish the centre at the Institute. As such a training fitted in very well with the extension project which is testing literacy as a method of approach, the Institute welcomed the opportunity and agreed to offer the limited facilities it had for a programme with as wide a scope as the one planned by Dr. Laubach. It was also agreed that the literacy centre would be established within the framework of the extension project. Accordingly plans were made for the following:

1. Training of organisers of literacy campaigns.
2. Training in simple writing for new literates.
3. Training of illustrative artists.

Literacy Centre, which began in February 1953 under the extension project, has held eight short training courses during its first year. Two hundred twenty five students from all parts of India have completed this training, which includes techniques of teaching illiterate adults and the art of writing for new literates. Trainees represent such groups as Community Projects, Srineketan, Gandhi Rural University, various Christian missions, and others. Educated villagers, recommended by the gaon sathis, also were admitted to the different courses and they returned to their villages as volunteer literacy workers. A special course was held at Landour, Mussoorie in May for the benefit of the gaon-sathis of the extension project. Fifteen gaon-sathis, representing about 150 villages, attended the course and received certificates.

Trainees have gone each evening to nearby villages for practical work which includes literacy surveys, organisation of classes, teaching of reading, writing and simple arithmetic, literacy publicity through audio-visual aids, examinations of progress and the conducting of literacy melas in co-operation with the villagers. During this year trainees have worked in six villages and have helped some 700 villagers who have demonstrated their ability to read and write letters, make out money orders, read signs and keep accounts. Forty of this number are employees on the Institute farm.

Literacy Centre staff have also given training in literacy methods to students of the extension short courses, home economics extension course and chief social education organisers training courses. Three two-day training courses in teaching methods have been given to villagers brought

in by the extension project. Frequent discussions have been held with gaons athis on their literacy problems and assistance given when required for conducting literacy examinations in the field and setting up literacy stalls at melas.

Tin Trunk Libraries:—Tin Trunk Libraries compiled by the Literacy Centre are helping to provide follow-up literature needed in the villages. Six different sets, each containing 50 books carefully selected to meet the needs of new literates, are being circulated in the villages. Sets have also been sold to literacy workers in other areas.

Writing workshops held during each month's training have given trainees experience in writing for new literates. Stories written by the first two training groups under the director of Dr. Laubach and Miss Margaret Runbeck have been compiled into six books of the Anandpur series. Technical Co-operation Mission of U. S. A. is financing the printing of these books. One Book, "*Purane Aur Naye Tarike*" is already off the press and others will be ready soon. Literacy House has also published "*Ham Government Hain*" (We Are The Government) and "*Literacy House Highlights*" a bi-monthly news-letter.

This year marks the 200th anniversary of the publication in 1753 of James Lind's book, "A Treatise of the Scurvy." In this book he points out the use of citrus fruits for the cure and prevention of scurvy. Lind, a naval surgeon in the service of the British navy, was a graduate of the University of Edinburgh and practised medicine in Edinburgh between periods of service. From the 15th to the 19th century about a million seamen died of scurvy. Lind did not identify ascorbic acid, vitamin C, as the active ingredient in these fruits which cured scurvy, but he did prove that orange or lemon juice cured or prevented the disease which was such a scourge of all navies and long-range sailing ships of those days. In 1795 an administrative order required each British sailor and marine be issued orange or lemon juice daily. It is said that Lind's work in hygiene and preventive medicine contributed as much to the downfall of Napoleon as did Lord Nelson's victory.

Bronze plaques honoring the memory of James Lind were placed in the University of Edinburgh, Scotland, and in the Sunkist Building in Los Angeles, California on May 22, 1953.

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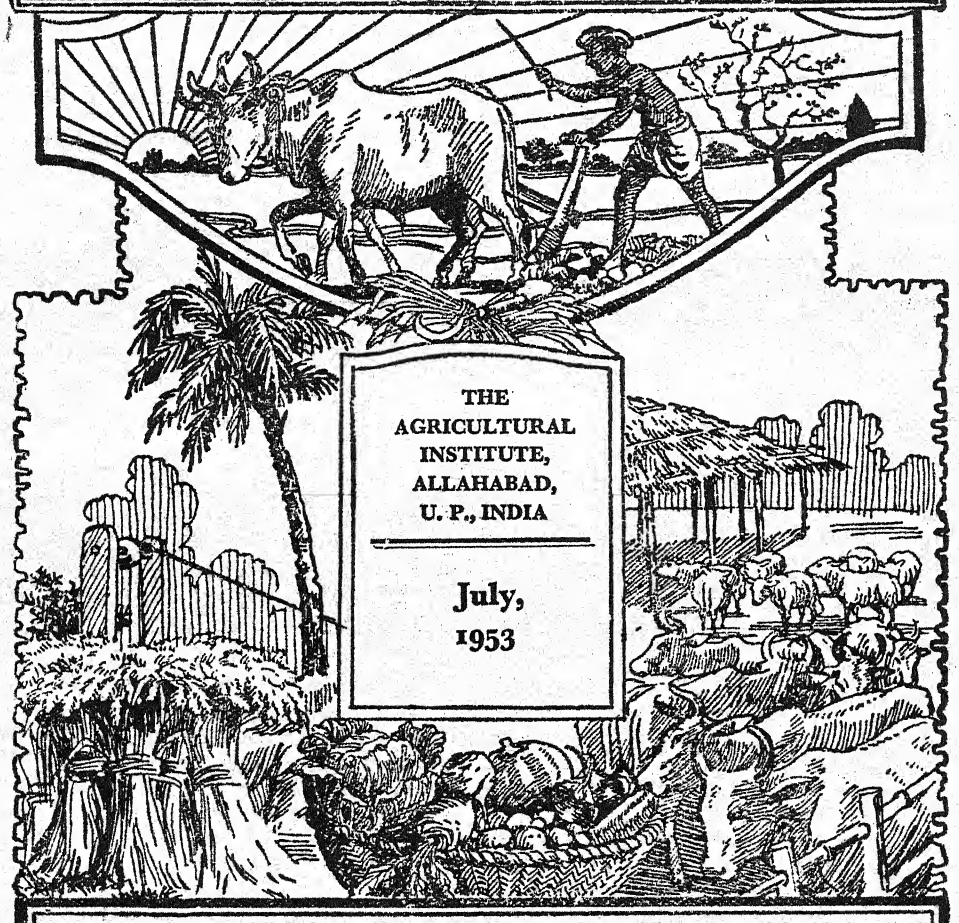
THE ALLAHABAD FARMER

A Bi-monthly Journal
of
Agriculture and Rural Life



THE
AGRICULTURAL
INSTITUTE,
ALLAHABAD,
U. P., INDIA

July,
1953

We shall conceive of the earth, which is the common habitation, as inviolable. One does not act rightly toward one's fellows if one does not know how to act rightly toward the earth.

—*Liberty Hyde Bailey.*

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THE ALLAHABAD FARMER

BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE

The ALLAHABAD FARMER is now approved by the Directors of Public Instruction in Uttar Pradesh, West Bengal, Madhya Pradesh, Sind, Assam, Bihar and Orissa, and by the Director of the Institute of Plant Industry, Indore, for use in all schools under their jurisdiction.

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The ALLAHABAD FARMER is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

Contributors will receive 15 reprints of the article published and additional copies at cost.

The views expressed in the articles are not necessarily those of the editor.

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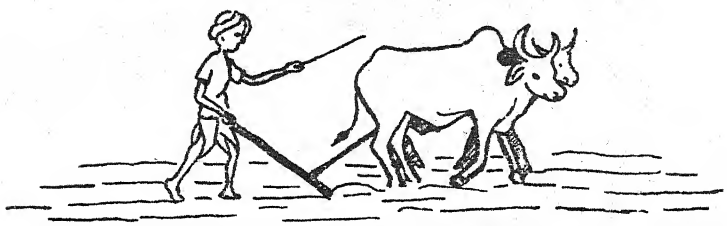


VOL. XXVII | JULY, 1953 | NO. 4

SUDAN GRASS

By

G. C. MAHANTA

Bihar Agricultural College Sabour.

Sudan grass (*Sorghum vulgare var. sudanenses*), a forage crop, has been introduced recently on the Bihar Agricultural College Farm, Sabour. It is a new crop for Bihar. This grass was first introduced into America in 1909 from Sudan, Africa, and it is from this country that it derives its common name, "Sudan grass." Its importance is due to its high forage value not only in America but in other parts of the world as well.

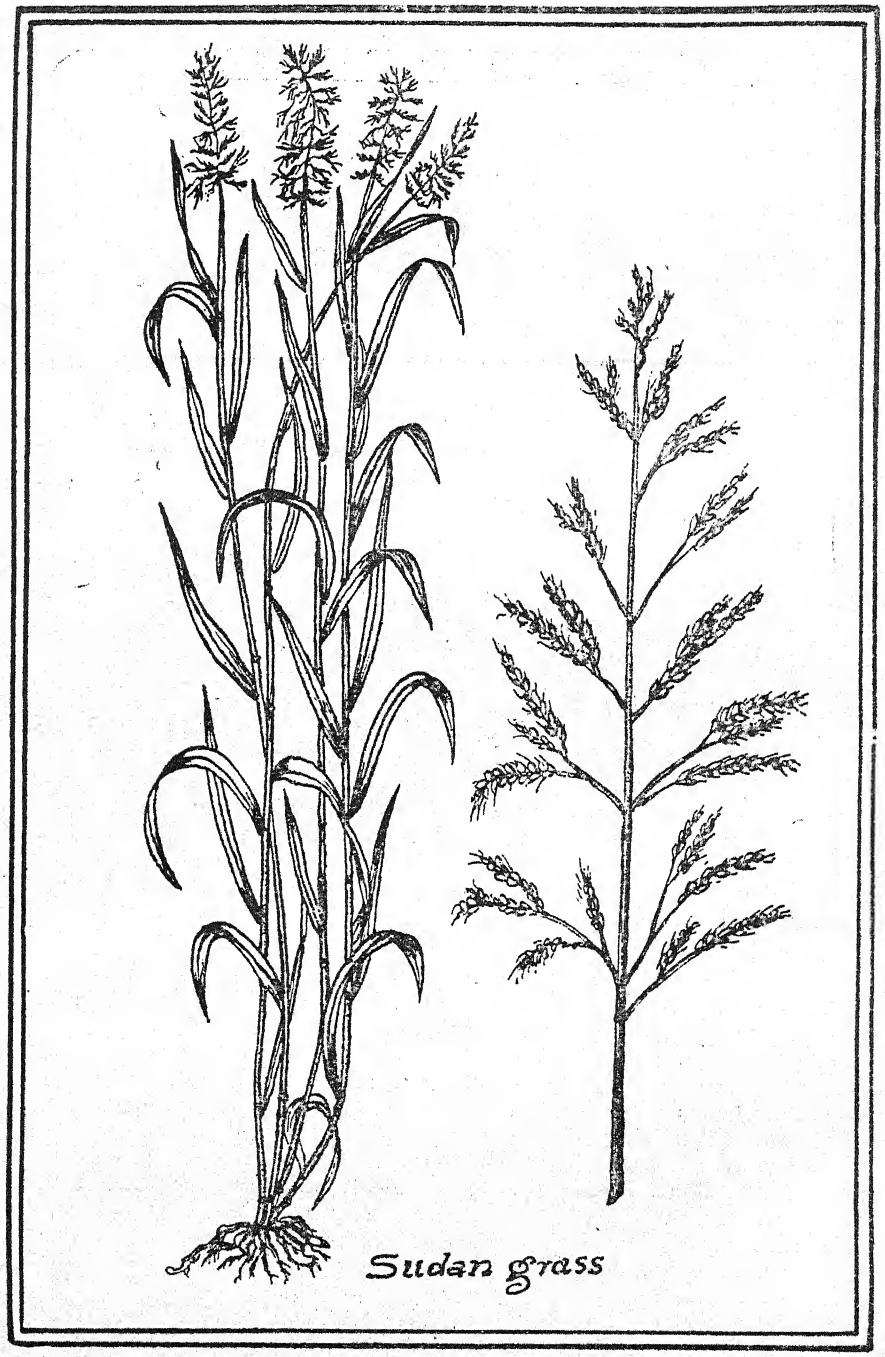
Botanical Description:

Sudan grass, an annual herbaceous plant, grows to a height of 8 feet. Its stems have 30-35 joints and are about ¼ inch in diameter, thus being less coarse than *juar* and maize.

It belongs to family Gramineae, series Spontanea, subsection Arundinacea in the section *Eusorghum* of the genus *Sorghum*[4]. The joints are closed or solid. The plant produces about 30 to 40 tillers per plan. Under extremely favorable conditions one plant may produce as many as 100 tillers. Its leaf consists of a sheath which envelopes the stem, a ligule and the blade. The blades are linear, alternate, parallel-veined and have light colored midribs. The leaves are narrow and shorter than those of *juar* or maize.

The laminae of the leaves are dark green in colour and somewhat thinner and more succulent than those of *juar* and maize. The inflorescence is a loose open panicle (see illustration), 6 to 18 inches long. The

hulls or glums generally carry awns 9 to 11 mm. long, but some strains are awnless. The flowers are bisexual (perfect).



Growing the Crop:

Sudan grass just like *juar* does well in a hot humid climate. It is generally sown in the month of June, at the break of the monsoon and harvested in August or September. In a propagational trial it has been found that it can be grown also in the winter season from either setts or seeds. It has also been observed that just like other grasses the shattered seed will germinate and produce a crop the next year. To start Sudan grass, the seeds are sown on a prepared seed bed in the same manner as *juar*. The seed rate depends upon the purpose for which the crop is intended. For seed production, it should be in lines at the rate of 8 to 10 lbs. per acre. For a soiling crop (green feeding) the seed may be broadcast at 20 to 25 lbs. per acre. This crop is seldom cultivated. Sudan grass becomes ready for harvest in 2½ to 3 months, which is somewhat less time than is required by *juar*, Nepier grass, or Guinea grass. The best time to cut Sudan grass is when it is in full head, but it can be harvested somewhat earlier or later than this with no material loss in feeding value. When seeded in the month of April or May as is practised with *juar*, under irrigated conditions it will produce as early as June green fodder, which will be more in quantity and better in quality than can be obtained from maize or *juar*.

The crop usually produces 2 or 3 cuttings, giving 150 to 200 mds. per acre in each cutting. The fodder is very palatable because of its succulent green leaves and their herbaceous stems and the cattle utilize every bit of the plant if it is properly chaffed. In the U. S. A. and other parts of the world it is also grown as a pasture grass, taking advantage of its capacity for self-seeding. When used for pasture it is often sown in a mixture with soybeans. When grown for seed, as much as 400 to 500 lbs. may be harvested per acre, i.e. nearly 5 to 6 mds.

Comparative Merit:

The following table will show the comparative merit of Sudan Grass and other allied crops, grown under similar conditions.

Chemical Analysis of Green forages[3]

Name of Crop	Dry Matter %	Mineral Matter %	Fat %	Crude Fibre %	Protein %	Nitrogen Free Extract %
Bajra ...	21.6	2.4	0.3	6.9	1.5	10.6
Guinea grass ...	26.4	3.3	0.2	11.1	1.3	10.5
Juar ...	30.8	2.9	0.7	10.8	2.8	13.6
Maize ...	20.5	1.8	0.3	5.3	1.6	11.5
Napier grass ...	23.8	4.0	0.5	7.6	1.3	10.5
Sudan grass ...	26.1	2.4	0.9	8.8	2.2	11.8
Teosinte ...	32.0	3.5	0.4	10·3	1.4	16.4

Advantages of Growing Sudan Grass:

(i) The prussic acid content of Sudan grass is very low and therefore it is less dangerous to feed to cattle than a larger Sorghum such as *juar*.

(ii) The root stock of the grass is less developed than *juar*, Napier grass, or Johnson grass and therefore it is not likely to spread as a weed.

(iii) It is as draught resistant as *juar* and much more so than maize.

(iv) Harvesting by a bullock-drawn or tractor-drawn mower is possible which is not true in the case of the coarse stemmed *juar* and maize.

(v) The tillering capacity of Sudan grass as compared to allied grasses is great. This is an aspect of vigour, which is desirable in a forage crop.

Care in Growing Sudan Grass:

(i) Sudan grass should not be grown primarily for silage because *juar* and maize are better crops for this purpose. They produce a high quality and a larger quantity per acre than Sudan.

(ii) It should not be grown in extremely dry soil or under unfavorable climatic conditions which favour the the development of Prassic acid which may cause poisoning.

(iii) In the production of Sudan grass seed it has been noted that the plant hybridizes very frequently with sorghum varieties[2]. So for seed purposes, the Sudan grass field should be at a considerable distance from *juur*.

Conclusion:

Sudan grass is being grown as a new introduction. Its cultivation may be increased first on government dairy farms. This will serve to demonstrate its value and indicate its adaption.

On account of its many advantages over the other forage crops its culture is destined to increase. Attention will also be given to its improvements through breeding. In fact a new variety of high palatability has been produced in the United States where it goes by the descriptive name Sweet Sudan.

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The Village Worker:

The key to village improvement lies in a dedicated working fellowship where the Extension workers and the people themselves join hands in an effort to lift, strengthen, and redeem all phases of village life.

As additional resources and personnel are dedicated to the improvement of village life it is important we make full use of the hard won experience gained from work in the past. Some essential parts of our experience may be summarized as follows:—

1. Think first of the village family. The village is theirs and life will be changed only by their good will and co-operation.
2. Value what the people have and work with them to improve it wherever possible.
3. Use outside funds or equipment sparingly. Local initiative has often been smothered by unwise generosity.
4. Help the people to set clear goals that are reasonably attainable and spare no efforts in helping to reach them. Evaluate the results regularly.
5. Use volunteer leaders. Real extension work depends upon the spirit of self-help.
6. While our goal must be a concern for all phases of life, it is best to begin with some simple or obvious need first and work from there.
7. Work "with the grain", using indigenous materials and methods as far as is practical.
8. Consider your colleagues and seek out ways to make your work helpful to them.
9. Co-operate with other agencies working for the improvement of village life.
10. Guard against mere secularism. Work for the Abundant Life with emphasis upon both material needs and spiritual values.

—FACING THE FUTURE IN RURAL MISSIONS
By Agricultural Missions, Inc.

A Word from I. V. S.

If you come to visit us at India Village Service at Marehra, in U. P., we can show you no institutions. But we can show you villagers teaching and being taught in homes in classes of one, two, or more. They are learning to read and write; to spin, sew and knit; and to engage in other useful arts and crafts, even to make soap.

We can show you fields where villagers have planted improved varieties of wheat and potatoes. There are also plots of fruit trees and vegetables. You will see people treating simple ailments of man and animal. And you will find people who are learning the meaning of personal hygiene.

There is a spirit of earnest inquiry, of democratic endeavor, of reflected love. The villagers recognize in our colleagues a confidence in the soundness of their teaching and in the forthrightness of their Christian witness. Now they know our colleagues are Christians and Indians and best of all, their friends.

W. H. Wiser

A New Village Gospel:

The objective of all this new planning must not be primarly the increase of food and wealth but the designing of a new manner of living and the finding of an incentive to make the effort necessary to achieve it. (Hunger, debt poverty, ill-health, and squalor are narcotics, not incentives). These two objectives are parts of one whole.

The standard of living is the standard of the home and the only possible incentive is the ambition for a better home. The standard of the home is the standard of the woman who keeps it, whose strongest instinct is the welfare of her family.

Home is the woman's job, but women in the less developed countries are only regarded as necessary drudges, of inferior status and not worth educating—that is why these countries are backward! Till, therefore, the women and their training, welfare and education are given top priorty there will be no general desire among these people for a higher standard of living.

All plans must start in and be built around the homes of the common people. The village people, particularly the women, must be encouraged and assisted by outsiders who already know what the elements are of a good standard of village life to suit the particular conditions of their race and country. This will involve a revolution in current ideas of administration and welfare services, but without it any efforts to help the less developed countries will be largely wasted.

In this attack upon the standard of living, literacy, and even more important, the production and distribution of good literature must be included, but it must be realized that among peasant farmers, petty craftsmen, and land workers the mother will always be the first teacher of the young. Even after they go to School, it is she who will be responsible for encouraging them in their efforts to become and remain literate. Literacy, therefore, must be brought to the women no less than the men.

The world's malaise, which communism is exploiting, is largely due to a rural and agricultural world (in which religion is still a potent force) being run by urban and industrial people who pay little more than lip service to spiritual things. The world wants love—love of neighbour, love of soil, love of craftsmanship—and is getting bulldozers and and big money. It needs humanity and is getting materialism.

Large-scale plans are undoubtedly needed as well as the intimate social work mentioned. But they will only achieve their purpose when the standard of living, that is better homes, becomes the main objective, and the foundations of modern civilization are firmly laid

by this program of the simple homely stuff, which we take for granted in the West but which to the under-developed countries is a new gospel of hope and life.

—the late F. L. Brayne.

Basic Conclusion:

As Consultant to the FAO, I have observed at first hand many of the high spots of the economics of the northern hemisphere. Through others I have learned much about the peoples and economics of the southern half of the world. As a result I have reached a few basic conclusions and they are given here for what they are worth.

1. All normal men have a religious faith of some kind.
2. Individuals are basically friendly.
3. The family is the most important unit of society.
4. It is the small things that really count in life.
5. The eating of meals is the most important daily occurrence in a person's life in the midst of plenty.
6. More people go to bed hungry every night than with full stomachs.
7. Over population is the result and not the cause of poverty.
8. "Decongestion" of metropolitan centres is the biggest industrial "must."
9. Most of the human race are farmers, fishermen, or foresters and the majority of these are without the means and knowledge to do their jobs properly. Land reform measures are as a rule long over due.
10. An extension service of primary produces is the common denominator to solve the problems relating to fields, fisheries and forests.
11. The homestead laws, the establishment of agricultural and mechanical (land grant) colleges, the promotion of rural credit, extension services, and vocational work among rural and village students are the foundation upon which the American industrial and agricultual economy has been built. Without this type of resistance from the Government our people would not have produced as they have or attained the standard of living which we enjoy.
12. The point IV program is sound if put on an international basis with a balanced adjustment between American knowledge and the knowledge of other lands, combined through the specialized agencies of the United Nations.

Raymond W. Miller,
Consultant to FAO.

VITAMINS AND HEALTH *

Vitamins are substances present in fresh natural foodstuffs, which are essential for health and well-being. The are present in food materials in very minute quantities, and the body also needs them only in very minute quantities. For example, cod liver oil, although one of the richest natural source of Vitamin D, contains only one part in 4,00,000 of that vitamin. But the body cannot afford to go without vitamins in spite of the fact that it only needs infinitesimal quantities of them.

The discovery of vitamins is a story of international co-operation in medical research. By the middle of the 19th Century, scientists had proved the presence of three principles, proteins, fats and carbohydrates, in food. But there was a missing ink, the nature and composition of which had eluded research workers for a considerable period of time.

In 1847, James Lind, a ship's doctor, proved experimentally that the disease known as scurvy could be cured by giving lemon juice or juice of other citrus fruits to the sufferers. In the early eighties, Admiral Takkaki of the Japanese Navy had proved the effectiveness of unmilled legumes in the prevention of beriberi. In 1897, Eijkman, a prison doctor in Java, discovered that fowls which had been fed on milled rice developed symptoms resembling beriberi. Casimir Funk, a Polish biochemist, produced in 1911 an extract of rice polishings supposed to be preventive against beriberi.

To Sir Frederick Gowland Hopkins goes the credit of establishing the separate identity of vitamins and of their need for the proper functioning of the human organism. The number of different vitamins recently proved to be essential to growth is so great that only doctors can remember their names. But the most important of them are vitamins A, C, D and the B group.

Vitamin A

Vitamin A deficiency is one of the factors responsible for a large number of cases of deficiency diseases in India. It is present in butter and ghee, whole milk, curds, egg yolk, liver, fish etc. Prolonged heating of ghee in an open pan destroys the vitamin. The richest known natural source of Vitamin A is the liver of certain fish like cod, halibut, shark and some Indian fish. Animal foods rich in vitamin A are, however, expensive.

The easiest and cheapest way of ensuring a sufficiency of vitamin A is to increase the intake of green leafy vegetables. Three ounces a day of the common leafy vegetables will furnish an adult's requirements. Mango, papaya, tomato, carrots, green and yellow fruits and vegetables are rich sources of carotene which is transformed into vitamin A in the body.

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* Issue by Press Information Bureau, Government of India.

VITAMINS OF B GROUP

The B group includes several vitamins. The lack of one of them, called thiamine, causes beriberi, in which there is partial or complete paralysis of the limbs due to degeneration of the nerves, often accompanied by weakness of heart muscle, leading to heart failure.

The richest sources of thiamine among ordinary foods are unmilled cereals, pulses and nuts, particularly groundnut. Diets based on whole wheat, any of the millets, raw homepounded rice or par-boiled rice, usually supply thiamine in sufficient amount. Even if the diet is based on highly milled rice, the danger of beriberi can be removed if two ounces of pulses are taken daily.

The lack of the other vitamins of B group causes such diseases as soreness of the angle of the mouth and the tongue, eye diseases, etc. In general, whole cereals, pulses and nuts are fairly good sources of most vitamins in this group, while the richest sources are yeast, milk products, liver and eggs.

VITAMIN C

Vitamin C deficiency leads to bleeding gums and retarded wound healing, while prolonged deficiency ends up in the disease known as scurvy, the symptoms of which are sore gums, painful joints and haemorrhages.

The vitamin is usually found in fresh fruits and vegetables, particularly the green leafy varieties which contain this vitamin in abundance. But stale vegetables rapidly lose their Vitamin C content. Pulses and cereals in the dry state do not contain the vitamin, but it is formed when they are allowed to sprout.

Sprouting is a simple process where the grains, after a preliminary soaking it water for about 24 hours, are spread out on a damp earth or a damp blanket and covered over with a moist cloth. The grain will have germinated in two or three days and should be consumed either raw or after cooking for a minimum period. Sprouting mung or green gram is a very good source of vitamin C.

There is one very cheap and common fruit, namely 'amla' or 'nelikai' which is one of the richest natural sources of Vitamin C. The fresh juice contains nearly 20 times as much Vitamin C as orange juice and a single fruit is equivalent in Vitamin C content to one or two oranges.

Though the heating or drying of fresh fruits or vegetables usuallly leads to the destruction of their Vitamin C content, 'amla' is exceptional in that it has certain substances which protect the vitamin. Hence, it is possible to have 'amla' preparations with a high Vitamin C content. Guava is another rich source. Mangoes are fairly rich in it.

VITAMIN D

Vitamin D deficiency causes rickets and deformities of the bones. It is found in liver and liver oils, egg yolk and in milk and ghee obtained from animals fed on green pastures and exposed to sunlight. Hence these deformities are apt to occur in infants living in dark houses and women who observe purdah.

Often the cheapest way of obtaining this vitamin is by exposure of the body to sunlight. Medicinal preparations of Vitamin D cost money but exposure to sunlight cost nothing. A good supply of this vitamin during pregnancy benefits the mother and helps to ensure the satisfactory future development of the child.

TRACE ELEMENTS*

By

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At the present time, attention is being focused on the possibility of increasing the productivity of soils of indifferent fertility through the agency of trace elements. Some spectacular results have been achieved and publicised, consequently many farmers are seeking further information on the subject. This article is intended to answer some of the question asked.

The Essential Elements.

Plants and animals make their growth from substances which, in chemical language, are called elements. In nature, the elements usually occur combined in various ways; for example, calcium, phosphorus and oxygen together form the compound, calcium phosphate.

It is customary to consider the essential elements as belonging to two groups, those required in relatively large amounts, and those necessary in minute quantities. The former group includes the common fertilizer elements, nitrogen, phosphorus, and potassium, as well as carbon, hydrogen, oxygen, sulphur, calcium, and magnesium all of which are essential to both plants and animals; in addition, animals need small amounts of sodium and chlorine.

The elements required in minute quantities are variously called "trace elements", "minor elements", "micro-elements," and "micronutrienis". Once used extensively, the term, minor element, is passing out of favour, because it may be misleading by suggesting that these substances play minor parts in plant and animal nutrition. This is not so. The trace elements necessary to plants are iron, copper, zinc, manganese, boron, and molybdenum; those necessary to animals are iron, copper, zinc, manganese, cobalt, and iodine.

While generally regarded as non-essential for plant growth, traces of iodine and cobalt, normally sufficient for the nutrition of grazing animals, are present in plants, together with more or less of the elements sodium, chlorine, fluorine, silicon, and aluminium. Traces of many other elements, regarded as non-essential, can be detected also. This is because the soil minerals contain a large variety of elements, and plants have the ability of acquiring traces of these from the soil, whether needed for their growth or not.

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*Issued by Australian Government trade Information Service.

Trace Element Deficiency

If a plant or animal is unable to obtain enough of a particular element for its normal requirements, a soil deficiency in that element is said to exist for that particular species. This may or may not mean that the soil is deficient in the element for other species, since plants and animals differ in their requirements and, in the case of plants, in their ability to extract the trace elements from the soil. Molybdenum deficiency, for example, occurs in cauliflowers on soils which may supply sufficient molybdenum for normal growth of other vegetables. Again, clovers have a higher demand for molybdenum than grasses, because it is necessary for the nitrogen-fixing processes of their root-nodule bacteria.

Other examples of plants having relatively high trace element needs, or poor extractive powers, are oats and red beet for manganese, swedes and mangels for boron, fruit trees for zinc, and subterranean clover for copper and zinc; while, among animals, sheep and cattle require cobalt, although horses apparently do not.

Diagnosis of Trace Element Deficiencies

PLANT AND ANIMAL SYMPTOMS. Trace element deficiencies are most readily detected where sufficiently severe to produce visual symptoms, such as abnormalities in the growth of plants, or ill health in animals.

Insufficiency of a trace element often gives rise to a disease with symptoms which are typical of the deficiency. However, where several deficiencies exist together, the symptoms may be complicated. Descriptive names have been given to many of these diseases. To quote a few examples, "falling" disease and "peat scours" in cattle, enzootic ataxia in lambs, and "wither tip" in cereals, are caused by a deficiency of copper; "coast" disease in grazing animals by a combined deficiency of cobalt and copper; "whiptail" of cauliflowers by a deficiency of molybdenum; "grey speck" of oats by insufficient manganese; "little leaf" of fruit trees by zinc deficiency; and "cracked stem" of celery and "cork" of apples by an inadequacy of boron.

Disordered growth of plants, such as stunting, and various forms of colouration and death of tissues in the leaves, are visual symptoms of nutritional upsets which may be due to trace element deficiencies. In this connexion, the technique of producing experimentally the symptoms due to insufficiency of the trace elements by growing plants under glasshouse conditions in water and sand cultures, has enabled symptoms to be identified in the field. But it should not be overlooked that disorders can arise from other causes, consequently, confirmatory tests are usually necessary to establish whether a trace element deficiency exists.

PLANT ANALYSIS. The trace element content of plants grown on trace element deficient soils is usually less than that of plants grown on normal soils. As a consequence of this, analysis of parts taken from affected plants can sometimes reveal a deficient element. But there are difficulties. It is necessary to know what is the normal trace element content in the same parts of healthy plants of the same species. When it is realized that the trace element content varies over wide limits for different species, and between different parts of the same species, and is also influenced by the supply of other nutrients and the stage of growth,

it is obvious that much preliminary knowledge of the chemical composition of plants must be available before analyses of unhealthy plants can be interpreted correctly.

There are also analytical difficulties. Most of the procedures involved are intricate, and the amounts of the elements to be estimated are exceedingly small. For instance, the copper content of leaves may be less than 10 parts per million of their dry weight, their molybdenum content less than 1 p. p. m.

Soil Analysis. Iron and manganese are always present in soils in substantial quantities, but mostly in unavailable forms. On the other hand, the total amounts of copper zinc, boron, cobalt, and molybdenum normally present are very small.

Little is known of the trace element content of Victorian soils-molybdenum may be less than 1 p. p. m. of soil, and copper, zinc, boron, and cobalt each only several parts per million.

At first sight, an analysis of the soil appears to offer a logical way of finding out whether there is a shortage or otherwise of one or more of the trace elements. But, unfortunately, soil analysis, like plant analysis, has serious limitations. Certainly the total quantity of each of the trace elements in the soil can be found, although such analysis is not a simple one. However, usually these figures are of little use, since much of the quantities found may be inaccessible to plants, and it is difficult to decide on how much is available, which is the important point. There is no way of doing this exactly, although attempts are sometimes made to assess the supplying power of soils for the trace elements by chemical or biological means. Such methods are not in general use for diagnostic purposes, because their usefulness has yet to be established for our soils and crops. In addition, some of the most promising methods are extremely delicate and require special skill and equipment.

There is a further complication, namely, that analytical soil data need to be correlated with established field effects before a satisfactory basis can be arrived at for diagnosis of trace element deficiencies by this means.

Field Trials. Frequently, diagnosis of a soil deficiency can only be made by trying out a number of the suspected elements on field plots. In point of fact, the field trial is the ultimate test for most trace element deficiencies. Such trials are little different from the ordinary fertilizer trials familiar to farmers, except that they are complicated usually by the larger number of treatments to be tested.

Spray Application and Tree Injection. If applied in a soluble form as a spray to the foliage, or as an injection into the limbs of trees, some trace elements can be absorbed directly into the plant, and will ameliorate the visual symptoms of a deficiency if these are not too far advanced. For example, zinc and iron deficiencies of fruit trees, and manganese in vegetables, can be tested for in this way.

Pot Tests. In pot tests, a susceptible plant, such as subterranean clover, is grown in the soil under test in a series of small pots which, as in a field plot trial, receive various combinations of the trace and other

nutrient elements. Glasshouse facilities are usually required and considerable care is necessary to avoid contamination of the pot soils with trace elements from outside sources.

Pot tests have the advantage that a large number of factors can be investigated simultaneously, observations on growth can be made conveniently, and the climatic factor is controlled. However, growing conditions are artificial, and pot tests cannot take the place of a field trial, but they frequently supply preliminary information which enables the number of possibilities to be tested subsequently in the field to be reduced.

Trace Element Toxicity.

Even if present in amounts not greatly in excess of sufficiency, the trace elements may be poisonous. Sometimes toxic quantities of the essential elements, iron, boron, molybdenum, copper, and manganese occur naturally in the soil and adversely affect the growth of plants or the health of stock.

Boron can be toxic if the water-soluble form in the soil is too high. For example, poisoning has been recorded in citrus in Victria on soils containing from 2 to 16 p. m. of water-soluble boron.

Ingestion of excessive molybdenum causes scouring in stock, and this sometimes occurs in stock grazed on herbage containing a few more parts per million of molybdenum than usual.

In very acid soils, harmful effects are sometimes attributed to iron and aluminium, but the most common toxicity in acid soils is due to manganese. Some disorders in fruit trees and in vegetables are suspected of being due to excessive manganese.

Naturally-occurring toxicities due to copper and zinc have not been found in plants, but excessive uptake of copper is considered responsible for ill health in sheep grazed on herbage of high copper content.

The occurrence of trace element excesses in nature, and the readiness with which poisoning can be induced artificially, are warnings against the indiscriminate application of trace elements, either to the soil or to the foliage of plants. Unlike the common fertilizers, a single application to the soil probably lasts for years, except in special cases.

Availability In The Soil.

Usually only a fraction of each trace element in the soil is accessible to plants. The proportion that is available depends on several soil factors. Of these, the reaction, that is, the degree of acidity or alkalinity, and the organic matter content, are the most important, particularly since these factors can be altered by agricultural practices.

The naturally-occurring iron, copper, zinc, boron, cobalt, and manganese compounds in the soil can be utilized by plants more easily under acid than under alkaline conditions. In fact, on some alkaline soils, plants are unable to extract sufficient copper, zinc, and manganese

for their requirements, although apparently adequate amounts may be present. On the other hand, some soils, including both acid and alkaline types, have insufficient total supplies of copper, zinc, boron, and cobalt; copper deficiency in subterranean clover on certain acid sandy soils is due to this cause.

Molybdenum acts in the reverse way, being least available to plants in acid soils. Alkaline soil conditions favour its availability.

Correcting Deficiencies.

Several ways of correcting trace element deficiencies are available. The commonest method is to apply a dressing of the deficient element to the soil, usually in the form of one of its water-soluble compounds mixed with superphosphate. Soil treatment induces an increased uptake of the trace element by the plant. Deficiencies of copper and cobalt in stock can be alleviated indirectly in this way. Alternative methods for stock are to drench, or to give the stock access to licks containing the deficient element, the former usually being preferred.

The normal soil dressing is only a few pounds, somes only ounces, of the trace element per acre. The compounds used for each particular deficiency, and the amounts commonly applied per acre in tests are: copper sulphate, 7 lb.; zinc sulphate (hydrated) 7 lb.; borax, 4 lb.; manganese sulphate, 28 lb.; iron sulphate, 56 lb.; cobalt sulphate, 4 oz.; sodium or ammonium molybdate, 2 oz. Larger quantities are used in certain circumstances, e. g., in some cases of deficiencies in horticultural crops.

The trace elements are most easily and evenly applied to the soil by incorporating them with the normal fertilizer dressing, or with a spreader such as sand or loose soil. The trace element compounds require to be finely subdivided but, even so, the small amounts involved make thorough mixing difficult, consequently, ready-mixed fertilizers are to be preferred.

The correction of deficiencies by spraying is sometimes practised with intensively grown crops. Spraying is rapid in its effects, but may need to be repeated with subsequent crops, or at intervals in the case of fruit trees. Soil application, while slower in action, is more lasting.

While there are soils of good general fertility which exhibit trace element deficiencies, it is emphasized that these deficiencies are more commonly associated with soils of low fertility. On such soils, it is important to meet all plant-food deficiencies if their productivity is to be substantially increased. Depending on their utilization, this will mean supplying adequate amounts of one or more of the elements, phosphorus, potassium, and nitrogen, and sometimes lime also, in addition to the lacking trace elements.

ESTIMATES OF GENETIC CHANGES IN AN INDIAN HERD OF RED SINDHI DAIRY CATTLE *

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An important aspect of the breeding program for the Red Sindhi herd of dairy cattle of the Allahabad Agricultural Institute (India) has been efforts to improve by selection the production of the purebred Red Sindhis. The crossbreeding of Jerseys with Red Sindhi and backcrossing to Red Sindhi have been described by Stonaker, Agarwala, and Sundaresan (14) in a previous paper. It was apparent from this program of backcrossing that the recent genetic change in the herd was dependent upon the rate of improvement int he bull-producing Red Sindhi herd. The number of animals in the breeding herd has been about 120 cows of milking age, with three Red Sindhi bulls and one or two other bulls used in crossbreeding. Twenty-two purebred Red Sindhi cows were the nucleus of the bull-producing herd.

Attempts to evaluate genetic changes in farm herds have been more nearly measures of the amount of difference between those saved and culled and the generation time required than measures of actual genetic changes. Because the managers of herds attempt to improve simultaneously the genetic composition and the environmental background of the herd, estimates of long-time genetic changes are largely deductive and lack the greater surety of direct experimentation. However, such analyses are of value, for they serve as guides in evaluating the components of selection pressure. Several workers have reported on various techniques for developing a satisfactory solution to the problem. Henderson (2) has refined the method of comparing successive records of cows as a guide to the probable environmental changes in the herd. He used this method in evaluating the noncontemporary progeny of dairy sires. Estimates of genetic change have been made from heritability values and knowledge of the actual selection pressure exerted. Heritability methods have been developed by Lush (4). Dickerson and Hazel (1) later showed the relationship between various degrees of culling, age of parents, and annual genetic progress. Recently, workers in the United Kingdom, applying the methods of Lush, Dickerson, and Hazel, made estimates on rate of improvement in several herds of dairy cattle. Rendel and Robertson (7) estimated that annual improvement in a closed herd of Ayrshires was 0.7 per cent of the average yield per year. Estimates that the annual improvement in pedigree herds in the United Kingdom was 0.4 per cent of the annual yield were made by Rendel, Robertson, and Alim (8). Techniques for increasing this rate of improvement were suggested by Robertson and Rendel (10). In the Fulani breed in Nigeria, South Africa, Robertson (9) estimated

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the genetic gain to be 2½ gal. per year, which amounted to about 1.7 per cent of annual yield.

Adaptations of these methods have been used in this study, but, in order to make estimates of probable genetic gain, it has been necessary to evaluate the heritabilities of the various traits, the progeny tests of the sires used, the amount of culling which has taken place, the generation intervals, and the effect of age on production.

Genetic history of the Allahabad Agricultural Institute Red Sindhi herd. Red Sindhi cattle do not constitute a breed, as thought of by Western standards, for registration of these cattle is a relatively recent government-sponsored innovation. The cattle have a common origin in that they come from the Sind Province of Pakistan. In the Institute herd, according to Saxena (11), there were five purchases of foundation cows. The first thirty were purchased about 1923 on the open market in Sind; twelve were purchased in 1929, sixteen in 1932, eight in 1935, and the last twelve in 1946. This last group had no effect on the herd and was later culled in its entirety. The parentage of the foundation cows is unknown ; it is said that they were selected as typical representatives of the Red Sindhi breed type. Early bull purchases included five from the Poona Agricultural College. These bulls were pedigreed in the sense that their parents and grandparents were for the most part identified. The two Poona-bred bulls, Kabir (99) and King Carr (87) were used extensively in the Institute herd and had first lactation daughters appearing in the milking herd from 1938 through 1948. In addition, some home-bred bulls have been used. No further introductions have been made which affected the herd in this study. A pedigree map of the herd, tracing to the introductions which had descendants in the herd during the period April 1949 to March 1951, was prepared. The inbreeding coefficients of the 1949-1951 calves averaged 7 per cent. Of the purchased, animals, two bulls and one cow have the highest direct relationship to the 1949-1951 sample. Sind Queen (442) and Kabir were 20 per cent directly related to the 1949-1951 calf crops. King Carr was 16 per cent directly related to these calves, Sind Queen was for many years the heaviest producing Red Sindhi cow in the herd. Kabir sired 61 purebred and backcross daughters which went into the milking herd, and King Carr sired 52 daughters which had at least one lactation in the herd.

Effect of age on production. In making heritability estimates, it appeared that in view of probable great differences in environment over a period of time, the dams should be compared within the same year of production. It was impossible to do this on the basis of the dams' first lactations because of the few daughter-dam pairs that could be derived from the data on this basis. Since it is a pre-requisite of the heritability estimate that the daughters are an unselected group, it was necessary to use their first lactation records. Therefore, the records of dams made in the herd in the same year were age-corrected and used. Age effects are not commonly taken into consideration in India when using the dams' records as criteria in selection. Although Sikka (12) had reported age correction terms for Indian cattle based on the widely used technique of paired lactations of the same cows, and Lush and Shrode (5) had developed correction terms for dairy cattle based on this method, it appeared that further investigation was needed in the present herd analysis.

From the Institute herd data, four different production-age curves were developed. These are shown in Figure 1. The first curve was developed by averaging the yields and ages of all cows in a given lactation. This method, as mentioned previously, included cow differences as well as age differences. The second method applied was that of paired lactations. It eliminated the effect of changes in herd population from lactation to lactation. This study yielded results differing markedly from those of previous studies made on the same basis, as shown in curve 3 of Figure 1. The

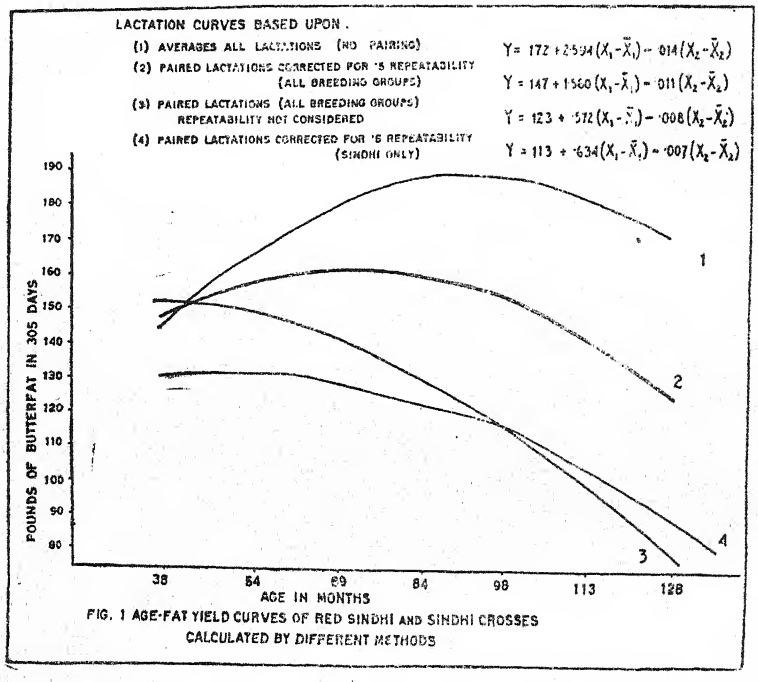

FIG. 1 AGE-FAT YIELD CURVES OF RED SINDHI AND SINDHI CROSSES CALCULATED BY DIFFERENT METHODS

first lactation records were the highest, and the production dropped off consistently in succeeding lactations. Robertson (9) noticed this same phenomenon in the Fulani herd he studied in Nigeria, although it was not mentioned whether it was observed as the result of pairing records of individual cows. Correction terms derived form this method of paired lactations gave very high corrections for the aged cows in the herd and led to corrected records for some of these older cows which exceeded any yields which had been produced in the herd. The combination of the effects of incomplete repeatability of records and selection on first records result in the first of a pair of lactation records of a cow being an overestimate of her later producing ability. Thus, while the first of a pair of records would be subject to temporary environmental influences on selection, the second record of the pair was free from this. The first records of each pair were corrected for this incomplete repeatability by multiplying the difference between the records before and after culling by the repeatability of 0. 5. (The correlation between first and second and second and third records was 0. 5 in this difference then was added

to the average of all cattle before culling and used as the real producing ability of the cows which remained for a succeeding lactation. The use of this method modified the correction terms considerably and resulted in the third lactation being the highest, but with slight age correction up to the fifth lactation when production dropped rapidly. (Curve 2 in Figure 1.) For the purebred Sindhi the curve was slightly different, and, with first records adjusted for incomplete repeatability, the first lactation remained slightly the highest. The correction terms were developed on the basis of correcting all lactations to a first lactation basis. In all case the curvilinear regressions of production on age were calculated by methods as outlined by Snedecor (13) .

Selection pressure on production charateristics of cows. Annual progress which may be expected in a trait is the product of the heritability of the trait and the annual selection pressure exerted on the trait. The latter is the result of both automatic and intentional culling. In the present study it was possible to measure selection pressure by calculating the average of the first lactation records of all cattle and then comparing this with the average of the first lactation records of the animals remaining in the herd for a second lactation. The process was continued to discover, as well, how much selection pressure had been made on 305-day production after the second, third, fourth, fifth, and sixth lactations. The result indicated that there was continued selection pressure among cows for increased production through the fourth lactation. Two other traits also were examined because of their bearing on total productiveness of dairy cattle. These were age at first calving and length of time between calvings. Again the measure of culling was based upon

TABLE 1

Selection of Red Sindhis for fat production, calving age, and first calving interval

	Before culling	After culling	Before culling	After culling
Lactation No.	(1)		(4)	
No. of cows	59	46	22	13
Lb. fat	134	140	115	135
Age at 1st. calving (*mo.*)	40.5	40.7	36.8	37.2
1st. calving interval	.....	.....	15.4	15.7
% surviving	.....	78	.....	22
Lactation No.	(2)		(5)	
No. of cows	46	30	13	9
Lb. fat	135	146	156	155
Age at 1st calving (*mo.*)	38.8	38.9	.....	.....
1st. calving interval	17.6	17.3	.....	.....
% surviving	.....	51	.....	15
Lactation No.	(3)		(6)	
No. of cows	30	22	9	5
Lb. fat	145	146	122	119
Age at 1st calving (*mo.*)	37.9	37.6	.....	.....
1st. calving interval	15.8	16.3	.....	.....
% surviving	.....	37	.....	8

the average age at first calving and length of time between calvings for all cows, as compared with the average of those which remained in the herd for another lactation period. For these two latter traits, there appeared to have been no effective culling, as is recorded in Table 1.

The advantage in production of those saved was particularly large in the first, second, and fourth lactations. For ages at first calving there was little difference between the general average and those saved for subsequent lactations. Thus, it did not appear that much selection was taking place on age at first calving.

Heritabilities of various traits. It is well established in numerous studies that heritabilities of various traits show a wide range in values (Philips, 6). As has been pointed out, for traits of equal economic importance it is more important to stress those which have the greatest heritability, for they will be the most responsive to selection. Two methods are commonly used for estimating the heritability of a trait from herd data. The regression of offspring on dam is doubled, or the intra-class correlation between paternal half sibs is quadrupled, to give an estimate. It is important that the offspring used be contemporary because of time changes in environment. Also they must represent unselected, or random samples of the offspring. In the present analysis it was necessary to use the intra-sire regression of daughters on dams in which all of the daughters were by Red Sindhi bulls, but the dams may have been crossbreds, various grades of Red Sindhi, or purebred Red Sindhis. Since the estimates in the study were of the genetic variation among the dams, they would be expected to be somewhat higher than if they had been on a purebred Red Sindhi population. Because of the limitation in number of data from the one herd it was not feasible to compare estimates based upon a population of crossbred dams versus one calculated from purebred dams. For butterfat production, the unselected first lactation records of daughters milking in the same year and by the same sire were regressed upon the age corrected records of their dams. Only the dams which had lactation records in the same year were compared, but their records were not made necessarily in the same years as their daughters records. The method of paternal half sibs was not suitable because of the few sires used in a given year. Heritability of per cent fat in the milk was based upon the same arrangement of daughter-dam pairs as in the butterfat yield study. It also was necessary to use

TABLE 2

Heritabilities of traits in the population of crossbred, backcross, and purebred Red Sindhi dairy cattle

Trait	Degrees of freedom	Heritability	Trait	Degrees of freedom	Heritability
Total butterfat in 305 days*	92	0.25	6-mo. weight	20	—0.05
% butterfat	82	0.09	2-yr. weight	21	0.18
Birth weight	37	—0.09	Mature height	18	0.78
Birth height	10	0.16	Age at first calving†	90	0.39
			Calving interval†	41	0.88

*, †, † Standard errors: 0.28, 0.16, 0.46, respectively.

the same arrangement for estimating heritabilities of such things as weight, height, age at first calving, and calving interval. For these latter studies this method of pairing left much to be desired, for although the daugh-

ters generally were under the same herd environment, dams within the group may have been under different environments when they were of an age to have their weights and measurements taken. The error terms of the heritability estimates were calculated for three traits which had the greatest number of degrees of freedom. These were so large as to cause almost any heritability value to be within the fiducial limits of the ones obtained. The heritability estimates are presented in Table 2. In spite of the large sampling error, these estimates are some evidence on selection opportunities. Heritability of total butterfat production was slightly higher than the estimates which have been reported for various breeds in the United States (Tyler and Hyatt, 15); it was lower than that reported in the study of the Fulani breed (Robertson, 9). In view of other studies (Tyler and Hyatt, 15) fat percentage heritability was particularly low. Mature height corresponded with that made in American studies. Ages at first calving and calving intervals were highly heritable.

Incidental to the heritability studies, the phenotypic correlations between traits were investigated. Sire and year of first lactation were held constant in computing these pooled correlations. They are shown

TABLE 3

Intra-sire, intra-first lactation year correlations between various traits of Red Sindhi and backcross females

Variables	Correlations	Variables	Correlations
Lb. fat · butterfat %	0.097	Butterfat % · mature ht.	0.006
Lb. fat · birth wt.	0.085	Birth wt. · 6-mo. wt.	0.316*
Lb. fat · 6-mo. wt.	0.169	Birth wt. · mature wt.	0.261
Lb. fat · mature wt.	0.140	Birth wt. · mature ht.	0.542†
Lb. fat · mature ht.	—0.060	6 mo. wt. · mature wt.	0.327
Butterfat % · birth wt.	0.002	6 mo. wt. · mature ht.	0.237
Butterfat % · 6-mo. wt.	—0.036	Mature wt. · mature ht.	0.676†
Butterfat % · mature wt.	0.026	Lb. fat in succeeding lactations	0.500†

* Significant at 0.05

† Significant at 0.01

in Table 3. The higher correlations were those between weights and measurements of the same animals. Rather striking, however, were the low correlations between size and 305-day production.

Progeny tests of the sires Five of the sires at the Institute had been used sufficiently to evaluate their progeny tests. Of the five, Kabir sired the most daughters in the herd over an 11-year period, and he was used as a check for ranking the merit of the other bulls. Kabir's daughters in the control group had first lactations in the same years as those in the compared groups. Thus the composition of the controls differed from time to time. The differences between the daughters' averages were corrected for the differences between the mates' averages. The ranking of the sires is shown in Table 4.

TABLE 4

Sire evaluations and the number of their Red Sindhi daughters

Sire comparisons	Av. butterfat differences in lb. between daughters of compared sires and between mates of compared sires			Rank of sires	Lb. B. E. sire 87 was exceeded	No. of Red Sindhi daughters
	Daughters (D)	Mates (M)	2D-M			
99-97	-27.3	30.0	-84.6	448	124	5
99-448	-46.0	-10.0	-82.0	617	123	14
99-617	- 3.0	75.2	-81.2	99	42	23
99-87	4.5	-33.5	42.5	87	0	14

The assumption was made that the average merit of these bulls should be a reasonable base from which to estimate the degree to which merit of sire determined the number of his daughters brought into the herd. Weighting the amount which each sire exceeded King Carr (the lowest ranking sire) by the number of his daughters gave an estimate of the total genetic change due to the sires used.

It was not known precisely how these sires compared with those in other herds. Indications were gained by comparing on an intra-year basis the first lactation records on Institute-bred Red Sindhis with the contemporary but on first lactation records of purchased Red Sindhis. Since the birthdates of the purchased Sindhis were not known, their records were not corrected. This introduced a bias in favor of the Institute Red Sindhis. The purchased cows were undoubtedly subjected to some selection in the herd and at the time of purchase, although lactation records were not available at the time of purchase. Thus, the comparison of purchased versus home-bred animals is comparing a selected group with an unselected group but with some disadvantage to the selected group because of age. The weighted difference was 7.45 lb. of butterfat advantage per lactation for the purchased Sindhis over a 9-year period, in which 62 lactations of purchased cows were compared with 49 first lactation Institute-bred cows.

Estimated annual genetic change. Estimates of annual genetic gain were adaptations of the Methods of Dickerson and Hazel (1). By their procedures, annual genetic gain =

$$\frac{\text{genetic superiority of dams} + \text{genetic superiority of sires}}{\text{av. age of dams} + \text{av. age of sires when progeny were born.}}$$

In this study the estimated total genetic gain in 16 years resulting from larger numbers of progeny from the better sires was 1. 53 lb. of butterfat. This amounted to 0. 1 lb. of butterfat per year or 0.7 lb. per generation of 7.29 years (the average age of the sires when their daughters were born). The estimate of genetic gain from the dams' side was obtained by calculating the phenotypic reach made as a result of the survival in the herd of the higher producing Sindhi cows. These values are shown in Table 1. This sum of the phenotypic reach was multiplied by the heritability estimate of 0.25 to provide an estimate of the average genetic superiority of the dams. The total estimated annual genetic gain in butterfat was then as follows:

$\{0.25\ [(0.78)\ (16) + (0.51)\ (11) + (0.37)\ (1) + (0.22)\ (20) + (0.15)\ (-1) + (0.08)\ (-3)\ ] + 0.7\ \}/(6.00 + 7.29) = 0.48$ (lb. per year).

As a percentage of average first lactation butterfat yield this amounted to about 0.3 per cent per year, an estimate which was a bit lower than that of Rendel, Robertson, and Alim (8) for probable average annual genetic increase in production of United Kingdom pedigreed dairy herds.

DISCUSSION

The estimates of progress in increasing production in this study were not discouragingly low in view of the small size of the Red Sindhi herd and the long generation intervals, and considering estimates of change in other dairy herds. However, recent information on techniques for increasing change would indicate, in view of this study and the preceding one on the performance of crosses and backrosses, that there may be opportunities to move ahead faster in the future.

If the present program of backcrossing to Red Sindhi continues there will be, as pointed out in the previous study, an almost certain continued drop in production per cow. However, an advantage will result from increased selection opportunities in a larger registered herd, for cattle with 31/32 Red Sindhi breeding may be registered. If the Red Sindhi cow herd grew from 22 to 122, there would be an opportunity for doubling the selection pressure on the dams of bulls. This would require that the herd be interbred in order to avoid the possibility of halving the amount which the herd pulls ahead of the breed average. Interbreeding in a herd of four sires and 120 cows would not need to cause the inbreeding to rise at a very rapid rate.

Efficiency of selection also could be increased by using 305-day lactation periods rather than average daily yield during the entire lactation or yield in the total lactation, for the latter methods tend to favor unusually short or long lactations. Weighting of information on 305-day records of the individual, or relatives, or both, as developed in Legates' (3) selection index, also should increase the effectiveness of selection of cows, young bulls and heifers.

As pointed out by Dickerson and Hazel (1), progress is also a function of the generation interval. The greatest opportunity for shortening this in the present herd would be in the use of younger bulls. The goal might well be to begin mating the bulls as soon as possible and to limit thier use to the production of 25 to 30 calves. The bulls might then be used on village cattle until their daughters' records were known. Proved bulls could be returned for further use where the genetic advantage of bringing them back into the herd is not cancelled by the corresponding increase in generation interval.. If the effects of increased size of the herd and decreased age of bulls could be achieved it would appear that increases due to selection might be doubled.

A properly weighted index including calving interval and age at first calving might produce a considerable increase in selection pressure for production per cow during a given period of time over selecting for production per lactation alone. Such a study would require more information on the economic importance of, and the genetic corelations between, these traits.

Lastly, anything which could be done economically to decrease the high death losses of heifer calves reported in the previous study would increase selection differentials through enlarging opportunities for culling on first lactations or in early disposal of those with inferior parents.

These goals for improving selection would entail considerable management effort and in some cases additional cost. It does seem likely that an achievement of one per cent increase in average per year could be attained, as indicated by Rendel and Robertson (7) as being the probable maximum in a herd of about the same size as this but using United Kingdom heritabilities and replacement rates. If this could be done, and if the theoretical assumption is correct that selection effects are cumulative and of a compound interest nature, then in 70 years one might have a purebred Red Sindhi herd producing as well as the first generation Jersey × Red Sindhi crossbreds produced in this herd.

SUMMARY

In the Red Sindhi dairy cattle herd of the Allahabad Agricultural Institute, which has been almost completely closed to outside breeding since 1934, the inbreeding of calves in 1949-1951 was about 7 per cent. Relationships were highest to Sind Queen, the highest producer of the foundation cows. She was the dam of two herd sires. Two herd sires purchased in 1935 also had a strong genetic influence on calves born in 1949-1951. These sires, King Carr and Kabir, had progeny born in the herd over an 11-year period.

The purebred Red Sindhi herd made up about one-sixth of the total milking herd and was the source of bulls for the entire herd. The estimated annual increase resulting from the better bulls siring more daughters and from the culling of lower-producing cows resulted in estimated increases of 0.5 lb. of butterfat per year or about 0.3 per cent of the average production per year. Heritabilities of calving interval, age at first calving, and measurements were above 30 per cent. Lower heritabilities were found for 305-day butterfat production, per cent butterfat in milk, and body weights.

Age corrections for purebred Red Sindhis devloped by correcting paried lactions for incomplete repeatablity indicated that the first lactation may be the most productive. For all cattle, including crossbreds and backcrosses, the third lactation was the highest, with but very little correction until the cattle reached the fifth lactation.

ACKNOWLEDGMENTS

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The Australian Government Trade Information Service reports on the importation of Afrikander cattle into Australia. Furthering its cattle-breeding experiments, the Commonwealth Scientific and Industrial Research Organisation is importing to Australia five Zebu and five Afrikander bulls and heifers from prize herds in Texas and Florida. The shipment will arrive soon by sea.

This is the first importation into Australia of Afrikander cattle, a tropical breed of Zebu extraction, indigenous to South Africa. It was not possible to import the cattle direct from South Africa, owing to Australia's strict quarantine regulations.

The arrival of these beasts will mark a further stage in the long-term cattle-breeding experiments being developed by the C. S. I. R. O. Division of Animal Health and Production, in conjunction with the Queensland Department of Agriculture and Stock, and the Australian Meat Board. The Board has bought the cattle for the C. S. I. R. O. as part of the foundation stock for the experimental heard for a new cattle-breeding research station near Rockhampton, in Northern Queensland, established on a property made available by the Meat Board.

The Zebus and Afrikanders will be crossed with Shorthorns and Herefords to develop experimental herds to investigate adaptation of the cattle to northern and tropical Australian environmets.

PRODUCTION CHARACTERISTICS OF CROSSBRED, BACKCROSS AND PUREBRED RED SINDHI CATTLE IN THE GANGETIC PLAINS REGION *

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The Allahabad Agricultural Institute (India) has long been engaged in breeding cattle for dairy purposes. The Institute is located in the Gangetic plains region, an area of great climatic stress due to variations from desert-like heat during April, May, and June, when day temperatures may reach 118° F., through the humid but less hot monsoon period of July, August, and September, to the dry, stimulating winters, which rather closely resemble summers in the high valleys of Rocky Mountains. It is generally believed, although precise information in this specific area is not available, that the specialized dairy breeds of Europe do not produce or survive in this area as well as do indigenous cattle. The primary interest in the villages has been on bullock draft power, and cows are maintained to produce bullocks. The buffalo is more highly regarded in this region as a milk animal and not infrequently produces twice as much as the cow. City dairies commonly may pay two to three times as much for a buffalo as for a cow. However, because in addition to the draft power of cattle there is religious encouragement in their maintenance, agricultural college and governmental personnel have been particularly interested in improving dairy qualities of the Indian and Pakistan breeds. This improvement is attempted by selection within the Indian breeds and in some dairies by crossing with European dairy bulls. The immediate increased productivity of cows sired by European dairy bulls has been known in India for many years. The "Taylor breed," an interbreeding population of cattle near Patna (Bihar), is said to have been derived from crosses of European bulls and native cattle as early as 1875 (Henderson, 2). Descendants of these crosses still are considered to be good producers, and Patna villagers have high regard for the milking qualities of these nonhumped cattle. Crossbreeding of Western with Indian cattle has been widely practiced on Indian military farms. This has been done at least since 1900, and records of production on these farms indicate that one-half to five-eighths Holstein breeding gives maximum production (5). This is substantiated by Tandon (13) in a more refined analysis of the data. Thus, it seems to be well established that introduction of European dairy sires has increased milk production in India over that obtained from the locally developed cattle, and it also appears that in other tropical areas the introduction of Indian breeding may increase productivity over that of the European

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breeds. Experiences in Jamaica (Howe, 3) indicated that Zebu crosses yielded considerably more than purebred Jerseys, Guernseys, or grades with less than half Zebu. In the United States recent experiments indicate that under Maryland conditions Jersey × Red Sindhi crosses may yield slightly more butterfat than do pure Jerseys (Fohrman, 1).

Practically ever since its establishment in 1910, the Allahabad Institute has been confronted with the problem of breeding profitable milk animals. Various breeds have been tried, such as Red Sindhi, Gir, Hariana, Sahiwal, and Kankrej. Crosses of these with Holsteins, Guernseys, Brown Swiss, and Jerseys have been made. Impressions of men who were in charge of the herd during the early years have been recorded by Schneider (10), Rathore (8), Tandon (12), and Saxena (9). Although detailed results with various breeds and crosses have not been reported, the observations of the men in charge led them to favor the Red Sindhi breed. The breeding program which has been followed was an adaptation of suggestions by Hutchinson and Joshi (4) as outlined by Schneider (10). The plan was to hold the comparatively high production of the crossbred cows and yet avoid the complications of continual intercrossing between the Jersey and Red Sindhi breeds. This was to be done by backcrossing to the Red Sindhi and simultaneously selecting for high production. The higher producing Red Sindhi cows were bred to Red Sindhi bulls, and the lower producing Red Sindhi cows were bred to Jersey bulls. The crossbreds then were backcrossed to Red Sindhi sires. This breeding program has been in effect since 1934. About the same time the record keeping was systematized so that the informational value of the herd was greatly increased.[2]

Rathore (8) reported on differences in growth of the Red Sindhis and their crosses. He found crossbred females exceeded pure Red Sindhis by 12 per cent in body weight at 2 years of age but by only 1 per cent in wither height. Tandon (12) in a study of gestation time of Red Sindhis and crosses found that the F^1 Jersey × Red Sindhi calves were born after a gestation period 5.8 days shorter than that required for the Red Sindhi calves. Production per lactation for all lactations in this herd of Red Sindhis, crossbreds, and backcrosses was reported in the Indian Ministry of Agriculture (5). Although changing environmental effects were not considered in records being made by different breeding groups at different times, records for the crossbreds were approximately 47 per cent higher than those for the pure Red Sindhis, and the various backcrosses generally decreased in production as relationship to the Red Sindhi increased.

ANALYSIS OF THE DATA

In the present study, production characteristics of Red Sindhi, F^1 Jersey × Red Sindhi, and first, second, and third backcrosses to the Red Sindhi were analyzed. A few data were available also on F^1 Brown Swiss × Red Sindhi and on $\frac{3}{4}$ Jersey × $\frac{1}{4}$ Red Sindhi crosses. With the system of continual backcrossing, periodically the breeding of the herd differed considerably. Thus, there was not a random distribution of each of the breeding groups such as F^1'', first, second, and third backcrosses

2 The establishment of the breeding plan was the work of Burch Schneider and N. R. Joshi, and the original policy has been continued by N. R. Joshi, T. W. Millen, and J. N. Warner.

during the different years. Because of this correlation between time and the genetic structure of the breeding herd, it was decided to follow a system of analysis whereby the first lactation records of each breeding group were compared with first lactation records of pure Red Sindhis made in the same year. First lactation records were chosen in order to avoid the possibility that differential culling in the groups might have taken place in subsequent lactations. Another assurance that first records would be relatively free from selection bias was the fact that there was very little culling of heifers in the herd. However, a certain bias in comparing the crosses with Red Sindhis was introduced because the lower producing Red Sindhi cows were bred to Jersey bulls and the better Sindhi cows to the Sindhi bulls. Thus, there was probably a genetic bias in the present analysis in favor of the Red Sindhis. Another limitation in the data came from the fact that only three Jersey bulls sired crossbred progeny; thus, the sample of Jerseys is particularly limited.

Although all crosses could not be compared at a similar time, it was possible to check each breeding group against contemporary first lactation Red Sindhis. The comparisons were made using procedures of the R × 2 tables described by Snedecor (11). Means and differences between means were weighted by this method for the various characteristics studied. Significances of differences were computed, using the same techniques of analysis.

305-*day butterfat yields.* Production of the cows in different breeding groups was measured from the total butterfat yields in 305 days of the first lactation. Fat yield was used in preference to milk yield in order to

TABLE 1.

First lactation 305-day butterfat yields of crossbreds, backcrosses, and Red Sindhis

Cross	No.	Weighted av. yield (*lb.*)	Check group	No.	Weighted av. yield (*lb.*)	Per cent of check group	Significance[a]
1/2 B. Swiss	11	220	Red Sindhi	22	143	153	**
3/4 Jersey	7	117	Red Sindhi	21	114	102	NS
1/2 Jersey	25	213	Red Sindhi	40	145	147	**
1/4 Jersey	68	162	Red Sindhi	63	130	124	*
1/8 Jersey	25	136	Red Sindhi	46	128	106	NS
1/16 Jersey	8	154	Red Sindhi	32	127	121	NS
1/2 Jersey	27	212	1/4 Jersey	35	172	124	*
1/4 Jersey	50	162	1/8 Jersey	25	135	120	NS
1/8 Jersey	17	156	1/16 Jersey	8	157	100	NS

[a] * Significant at 0.01 level; ** significant at 0.05 level; NS—nonsignificant.

eliminate the possibility that milk output should be corrected for the energy value. Generally in India, either daily milk yield or milk yield in the entire lactation is the record used. For cows which have very short lactations, daily milk yield would tend to be deceiving. Likewise, total amount of milk produced in an unusually long lactation would tend to favor cows with long calving intervals. At the same time, it seemed to be accepted in India that annual calving is a desired objective (Joshi, and Warner, 6); so it appeared that the 305-day lactation record was a more accurate measure of desired production characteristics than either daily yield or yield in the total lactation period.

The data in Table 1 on butterfat production behave in a pattern similar to that found in other Indian herds (Tandon, 13), in that the crossbreds showed great superiority over the pure Indian breed and that backcrossing to either breed tends to have an adverse effect on production. The association appears clear cut except for the unexpected high production of the few 1/16 Jerseys. Checking among the crosses, however, did not bear out this evidence of superiority of the 1/16 cross. Thus, it would appear that on a first lacttaion basis the production of animals with 1/8 Jersey or less will be only slightly higher than pure Red Sindhis. This would substantiate experimental evidence in other countries that the production of grade cattle is approximately the same as the purebreds after two to four backcrosses.

In Figure 1 the performances of first lactation Red Sindhis and crossbreds are shown by years.

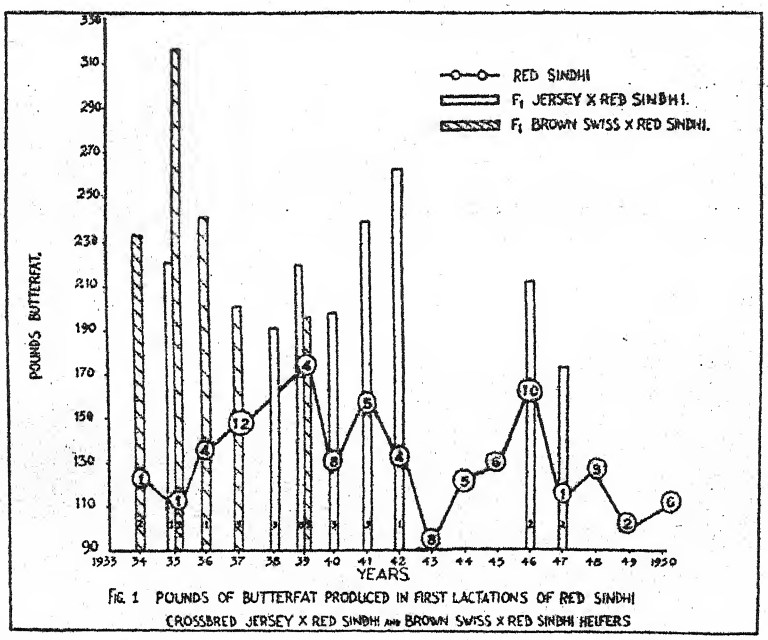


FIG. 1 POUNDS OF BUTTERFAT PRODUCED IN FIRST LACTATIONS OF RED SINDHI CROSSBRED JERSEY X RED SINDHI AND BROWN SWISS X RED SINDHI HEIFERS

Age at first calving. Table 2 indicates that there were large variations in ages of the different groups at first calving. This is particularly important, as it determines how quickly the cow comes into her productive life. Ability to calve at an early age would be considered a desirable trait. Comparisons again were made on the basis of weighted differences between the averages of heifers calving in the same year.

Age at first calving appeared to be greatly decreased by the introduction of Jersey genes. The greater the relationship to the Jersey the younger was the comparative age at first calving. No comparisons beyond ¾ Jersey relationship were possible. Variations in the calving age of Red Sindhis in the pairs of comparisons were due to the effect of heifers calving in different years.

Calving intervals. Breeding efficiency of the various groups was evaluated by the length of time elapsing between the births of the first and second calves. Delayed calvings appear to decrease total lifetime milk production and increase generation intervals. Thus, it is a trait of economic interest. In Table 3 the interval between the first and second calves was compared for cows having their first calves in the same year.

TABLE 2

Months of age at first calving for crossbreds, backcrosses, and Red Sindhis

Cross	No.	Weighted av. (*mo.*)	Check group	No.	Weighted av. (*mo.*)	Per cent of check group	Significance
3/4 Jersey	5	31	Red Sindhi	13	47	66	**
1/2 Jersey	27	29	Red Sindhi	49	41	71	**
1/4 Jersey	77	36	Red Sindhi	71	40	90	**
1/8 Jersey	30	39	Red Slndhi	51	43	91	**
1/16 Jersey	10	41	Red Sindhi	36	47	87	NS
1/2 Jersey	27	27	1/4 Jersey	37	33	82	**
1/4 Jersey	59	39	1/8 Jersey	30	38	102	NS
1/8 Jersey	21	42	1/16 Jersey	10	40	105	NS

TABLE 3

Interval in months between first and second calves for crossbreds, backcrosses, and Red Sindhis

Cross	No.	Weighted av. (*mo.*)	Check group	No.	Weighted av. (*mo.*)	Per cent of check group	Significance
3/4 Jersey	3	12.4	Red Sindhi	6	18.2	68	*
1/2 Jersey	23	23.8	Red Sindhi	31	14.2	97	NS
1/4 Jersey	53	16.0	Red Sindhi	53	17.0	94	NS
1/8 Jersey	11	17.1	Red Sindhi	32	17.4	98	NS
1/16 Jersey	6	17.9	Red Sindhi	24	16.9	106	NS
1/2 Jersey	24	13.8	1/4 Jersey	28	14.9	92	NS
1/4 Jersey	38	16.7	1/8 Jersey	13	17.5	94	NS
1/8 Jersey	8	17.1	1/16 Jersey	5	18.0	95	NS

TABLE 4

Calving intervals gross averages for cows of different breeding

	Calving intervals											
	No.	1st	No.	2nd	No.	3rd	No.	4th	No.	5th	No.	6th
		(*mo.*)		(*mo.*)		(*mo.*)		(*mo.*)		(*mo.*)		(*mo.*)
Red Sindhi	69	16	59	15	53	14	37	13	28	14	20	15
1/2 Jersey	27	13	26	13	21	14	12	14	17	15	15	16
1/4 Jersey	56	16	36	14	28	16	16	16	9	16	5	16
1/8 Jersey	13	18	8	16	5	20	1	21	1	16	1	14
1/16 Jersey	6	18	4	16	2	16	1	14	...	...	...	...

Although numbers and differences were too small to be significant for pairs of comparisons, the consistency with which the crosses had slightly shorter calving intervals than the Red Sindhis made it appear that there was a small but probably real difference between the crosses and the Red Sindhis is this characteristic.

A less precise but more inclusive analysis included calving intervals subsequent to the first (Table 4). Its lack of precision was due to confounding of years and breeding groups. The effect of lumping all years together without considering the fact that different breeding groups made records in different years is illustrated by comparing the column on first calving interval of this table with the previous table.

Butterfat percentages. The percentage of butterfat in milk was studied also by comparing crosses with pure Red Sindhis within years. The crosses had almost the same butterfat percentages as the Red Sindhis, with a tendency to be slightly higher. Table 5 shows the average butterfat content of the various groups in their first lactations.

TABLE 5

Butterfat percentage in milk from crossbreds, backcrosses, and Red Sindhis

Cross	Mo.	Weighted av. (%)	Check group	No.	Weighted av. (%)	Percent of check group	Significance
1/2 Jersey	25	4.95	Red Sindhi	34	4.86	102	NS
1/4 Jersey	74	4.82	Red Sindhi	66	4.77	101	NS
1/8 Jersey	26	4.87	Red Sindhi	46	4.71	103	NS

Relative rate of disappearance from the herd. The question of survivability as it refers to the longevity of animals was scarcely answerable in these data, since the cows had been continually subjected to culling. At times the policy was to increase the herd and at other times to decrease it. Since the production of the different breeding groups also had varied from time to time, there was difficulty in disassociating the policy concerning herd size and the amount of culling that was being done on the crosses produced at that time.

An indication of the total survival rate in the milking herd was obtained from a study of the number of animals in different breeding groups in the first, second, third, fourth, fifth, and sixth lactations. These animals had first lactations between 1937-1943; thus, they were of ages which could have had six lactations by 1950-1951.

It is difficult to draw definite conclusions from these comparisons. One difficulty is that widely differing numbers of animals were brought into the herd from year to year. It seems fairly certain that the crosses had not been culled as heavily as the Red Sindhis, and this is an indication that their productian and survivability had held up well over a period of time.

Death losses among heifer calves to 6 months of age could be analyzed for the period of 1943 to 1951, but there were not enough data to remove year effects. In these years ⅛ Jersey, ¼ Jersey, and Red Sindhi calves were born annually. Records were not available on the F_1 's born in earlier years, nor could records on bull calves be used, for these calves generally were disposed of shortly after birth. During this period the ratios of heifer calves alive and dead at 6 months of age were as follows : ⅛ Jersey — 42 alive, 28 dead; ¼ Jersey — 14 alive, 17 dead; Red Sindhi — 41 alive, 40 dead. In comparison with the Red Sindhi

group, neither the ¼ Jersey gave significant Chi-square tests, although the latter group approached a 0.05 level.

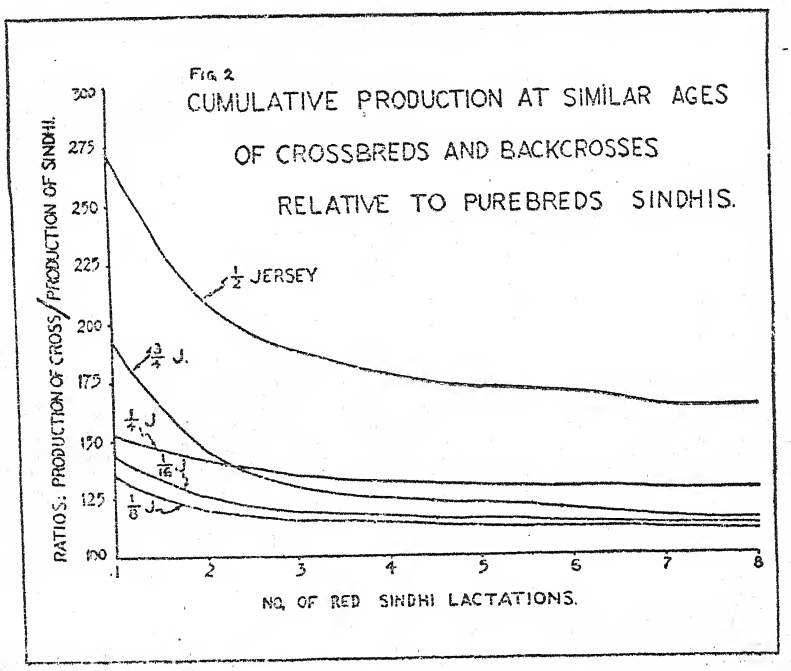
Thus, from the fragmentary evidence available on adults and young animals, there appears to be greater total survivability of animals with some Jersey breeding. It is certain that the F_1 cows have remained in the Allahabad herd much longer than the Red Sindhis. So far as viability of young stock is concerned, differences were not significant. All groups showed rather heavy death losses up to 6 months of age.

DISCUSSION

The two characteristics in which the crosses showed the greatest increases over the Red Sindhis were to a degree multiplicative in their effect on production in a given period of time. Thus, the crosses not only gave more milk per lactation but they began their productive life earlier than the Red Sindhis. In a population in which there was no intentional culling it would be possible to estimate properly total lifetime productivity of the different breeding groups. In this study, however, it was not possible to do this because of the differential culling rates in the various groups. It seemed likely that this came about largely because of differences in production of the different groups. However, if it can be assumed that the differences in the first lactations are representative of differences in later lactations, a reasonable assumption considering previous analyses of all lactations in the herd, then it it possible to make an estimate of lifetime production of the crosses and Red Sindhis. The advatage of crossbred or back cross cows over Red Sindhi cows of the same age can be expressed as the number of lactations of the crosses $(n + x)$ relative to the Red Sindhi lactations (n) multiplied by the ratio of first lactation production of the crosses (J) to the first lactation production of Red Sindhis (S), or $\frac{(n+x)}{n}\left(\frac{J}{S}\right)$. Thus, for example, at the age when Red Sindhi cows have finished their first lactations, Jersey × Red Sindhi cows have almost completed a second lactation and have given 2.72 times as much total yield. As the ages increase, the relative advantage of the cross decreases because of the diminishing effect of the earlier age at first calving. However, if one weights the advantages at different ages by the number of cows of these ages in the herd, crossbred or backcross populations would produce on the average relative to the Red Sindhis as follows : ½ Jersey, 2.09; ¾ Jersey, 1.47; ¼ Jersey, 1.39; ⅛ Jersey, 1.18; and 1/16 Jersey, 1.25. Thus earlier ages at calving boost the lifetime production of the crosses and backcrosses considerably above the estimates on a single lactation basis. Figure 2 shows the estimated production of each breeding group relative to Red Sindhis. Differences in calving intervals were not included in this circulated production because of the nonsignificance of differences in this trait. It would appear, in view of Rathore's study (8) on body sizes of the crosses that these increases in production exceed that which would be expected on only an increase in body size basis.

The data in this study indicated that with continued backcrossing to the Red Sindhi, little could be done to hold the production of the Jersey introduction. The original plan of crossing and then selecting from the backcrosses would be expected to work if there were but few genes involved and if the trait were highly heritable. For example, a rather marked degree of success has been obtained in introducing the polled gene

in some cattle strains in this way. However, the available evidence has indicated that the number of genes involved in explaining differences in yield in dairy cattle must be at least seven to ten pairs and very likely is due to a hundred or more pairs of genes (Lush, 7). Coupled with this, the heritability of milk or fat production is fairly low, and it would be



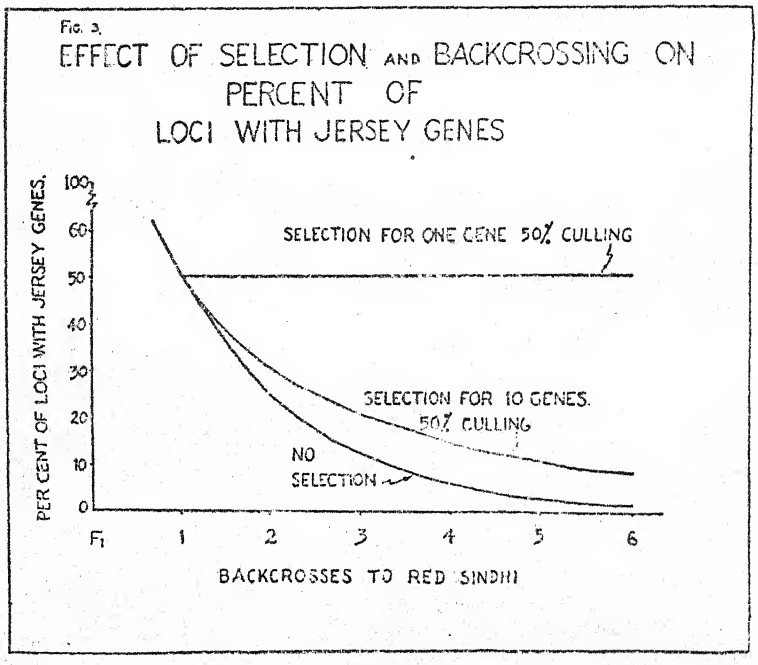
expected that there would be many mistakes in selections. Thus, theoretically it would appear unlikly that much could be done to hold the production of the crossbred while backcrossing to the Red Sindhi. Figure 3 shows the effects of 50 per cent culling with no mistakes (100 per cent heritability) and with different numbers of genes on ability to hold desired genes from one parent breed while backcrossing to the other one of the parent breeds. In the present instance, it appeared that actually as well as theoretically the production of the backcrosses rapidly approaches the production characteristics of the Red Sindhi parent. If the production characteristics of the Jersey × Red Sindhi cross were to be maintained some method other than that which has been used would be needed.

The point in Figure 3 were plotted by expanding binomials with one and ten gene pairs, selecting the top 50 per cent of the genotypes in the F_2 dams, and calculating for their Red Sindhi sired progeny the average number of loci-carrying Jersey genes. The process was repeated to procure estimates for subsequent backcross generations.

SUMMARY

In the herd of crossbred Jersey × Red Sindhi backcross and purebred Red Sindhis of the Allahabad Agricultural Institute, dairy

performance as related to breeding has been studied. In percentage of butterfat in the milk, the crosses have shown slight but nonsignificant increases over the purebred Red Sindhis; neither have there been signifi-



cant differences in the length of calving intervals or in survivability of young calves for the different groups. In comparison with purebred Red Sindhis, great differences have appeared in the advantages of the crossbreds particularly, and to a lesser degree of the backcrosses, in ages at first calving and in the production of butterfat in lactation periods of 305 days. Of the cows having first lactations, over twice the proportion of crossbred cows have remained in the herd for a period of six lactations as have purebred Red Sindhis. If total production for the number of years cows remain in the herd is computed from the data on age at first calving and production in the first lactation, then the production of a herd of F_1 Jersey × Red Sindhi would exceed by 2.09 times that of a herd of purebred Red Sindhis. The ratios of calculated lifetime productions of populations of backcrosses to the Red Sindhi were as follows : ¾ Jersey, 1.47; ¼ Jersey, 1.39; ⅛ Jersey, 1.18; 1/16 Jersey, 1.25. These ratios were computed by weighting the number of cows of different ages by the advantage of each of the breeding groups at that age. It appeared as a result of this study that all proportions of Jersey breeding used exceeded the production of the Red Sindhi, with the amounts decreasing as relationship to either Jersey or Red Sindhi deviated from 50 per cent.

ACKNOWLEDGMENTS

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MALARIA*

Malaria is an intermittent fever, characterised by shivering and a sensation of cold when the fever rises. Malaria is caused by parasites. When these parasites are introduced into the bloodstream of a person, he contracts malaria. The malarial germs are spread by mosquitoes. When a mosquito bites a malaria patient, the germs present in the blood are sucked into the stomach of the mosquito, where they develop. When the mosquito next bites a healthy man, the germs are injected into his blood-stream, who in turn gets the fever. In this way the mosquito may infect many healthy people. It should also be remembered that one malaria patient may infect thousands of mosquitoes, which will further spread the disease. Thus, the mosquito is our worst enemy.

Mosquitoes breed in paddy fields, ditches and drains, in tanks and pools. Any patch of stagnant water will encourage mosquito breeding. The mosquito lays eggs on the surface of the water. The eggs hatch, and in a short period, the insect passes through the various stages of its growth, the larval and pupal, to emerge as a full grown mosquito. During the day time the mosquito hides itself in dark corners, behind clothes and books and furniture and where water pots are kept. They generally come out and feed in the night.

Malaria can be eradicated only if the mosquito is killed. We should therefore not only protect ourselves from mosquito bites, but also make it impossible for the mosquito to breed and multiply. All ditches, holes and depressions near about houses should be filled with earth and levelled so that water may not collect in them. Drains should be kept clear so that water does not remain stationary. Kerosene oil should be sprayed over pools, tanks, drains, and the adjoining moist earth to prevent breeding. Fish should be introduced into tanks; mosquito larvae are eaten by the fish. Rub mustard oil over exposed parts of your body, or sleep under a mosquito net, the mosquito net should not be torn, otherwise it will be no protection at all. All water jars should be kept covered, and the stands regularly dried.

Did you know that in India millions of people who have suffered from malaria have enlarged spleens, are anaemic and succumb easily to other diseases; that many of them die?

As soon as you suspect malaria, call a doctor and begin proper treatment. As soon as the fever starts, take a tablet of paludrine with water three times a day. Children between 1 and 6 years of age should be given a quarter tablet and those who are 6 to 12 years old should be given half tablet. Malaria patients need not observe any diet restrictions; they should drink plenty of water. An adult should take 2 tablets of 5 grains each of quinine each day, if paludrine is not available.

REMEMBER NO MOSQUITOES NO MALARIA
KILL THE MOSQUITOES

*Adopted from a pamphlet in Hindi by Dr. M. S. Hayes and Dr. Ram Dulare of the Jumna Mission Dispensaries, Allahabad and Mr. Joshi of the Extension project, Allahabad Agricultural Institute and published by the Extension Project, Allahabad Agricultural Institute.

SMALLPOX*

Smallpox is a contagious disease. It affects young and old alike, and if not properly treated, may cause blindness, disfigurement and even death. The symptoms are fever with eruptions all over the body, which leave permanent scars. Contagion occurs by mere proximity to a smallpox patient, and by infected clothing and utensils or by direct contact. The popular belief that smallpox is caused by the goddess Bhavani or Shitala has caused a lot of misery in as much as proper medical advice is quite often not sought, and treatment is neglected.

We can banish smallpox from our homes and villages by getting ourselves and our families regularly vaccinated, and by persuading others to do the same. It is also necessary to segregate a smallpox patient during treatment. Children should be first vaccinated when they are three months old. When there is an epidemic, even a new-born child may be safely vaccinated. As soon as a case of smallpox occurs in the neighbourhood information should be sent to the nearest vaccination centre, and every person in the locality should get himself vaccinated. If facilities for this are not available in the village, one should go to the nearest doctor and get vaccinated.

Care of the patient:

As soon as smallpox is suspected the patient should be put in a clean, well ventilated room by himself. He should be given comfortable bedding, and put on a light, nourishing, easily digestible diet, *e. g.* milk, rice, pulse, fruit, etc. He should be allowed to rest undisturbed, and no one should be allowed to enter the room, except the person nursing him. It is essential to call a doctor immediately so that proper treatment may be given. The patient should have separate earthen vessels for spitting and for calls of nature; the contents should be regularly burned or buried. Any pieces of cloth used to clean his nose or wipe the face, should be burned immediately. When the scabs start peeling off, the body should be rubbed with some sweet oil. It must be emphasised that no one should have access to the patient till scabs have completely peeled off. When no scabs remain, the patient should be given a bath every day. The patient's utensils and clothes should be thoroughly boiled and put in the sun to dry. Bedding should be burned or exposed to the sunshine.

Some points about smallpox

In the first stage, the patient gets high fever, and displays signs of nervous anxiety; there is also a tendency to vomit. On the third day, small eruptions break out all over the body. These eruptions first appear on the face, chest, neck and hands; they spread to the mouth, throat, nostrils and to the eyes, causing eventual blindness. In the beginning, the eruptions are hard, but later become filled with water and pus. With suppuration, the fever rises. When they dry up, they form scabs. At this stage the fever subsides. Finally, the scabs peel off.

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*Adopted from a pamphlet in Hindi written by Dr. M. S. Hayes of Jumna Mission Dispensaries, Allahabad, and Mr. Joshi of the Extension Project, Allahabad Agricultural Institute, and Published by the Extension Project, Allahabad Agricultural Institute.

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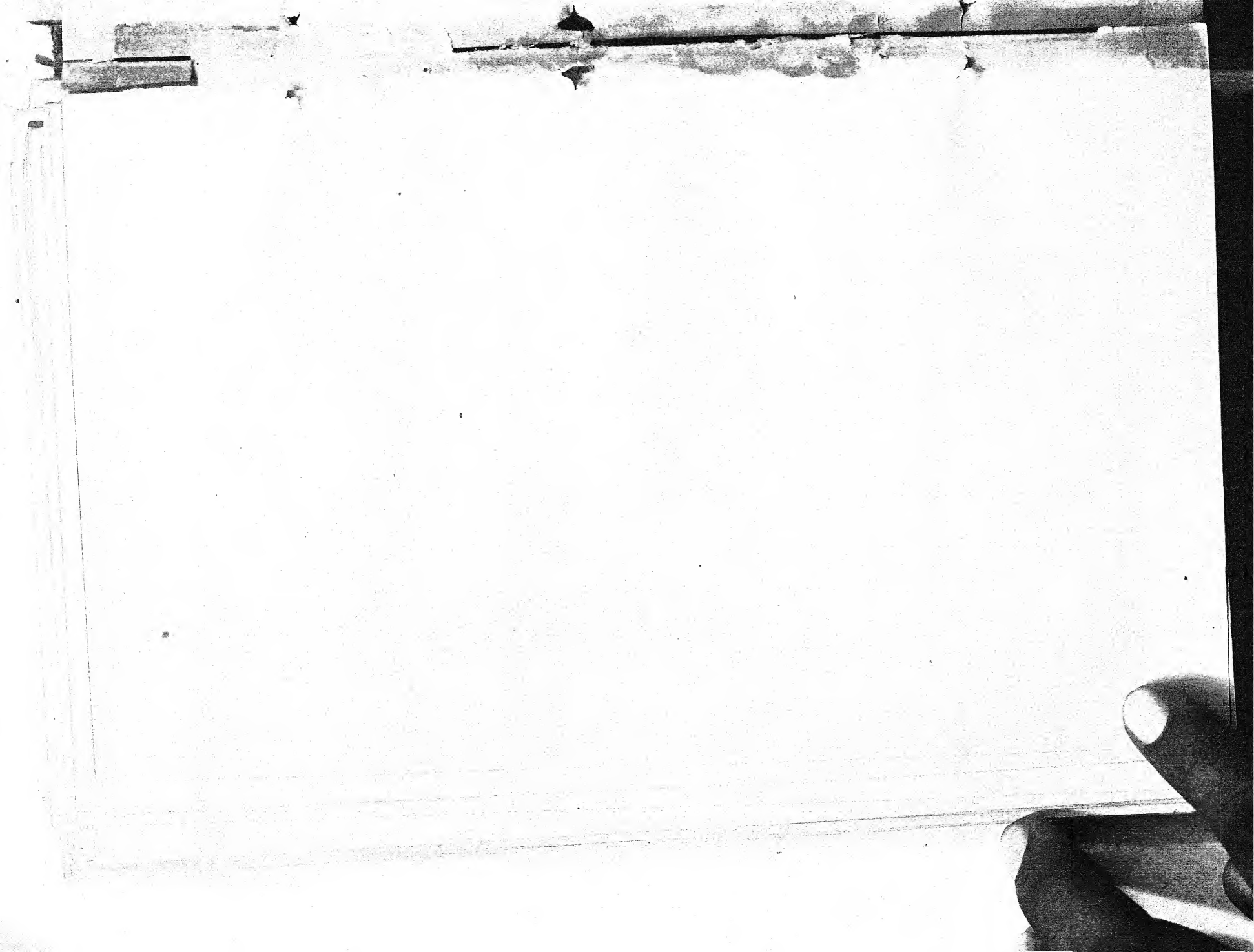

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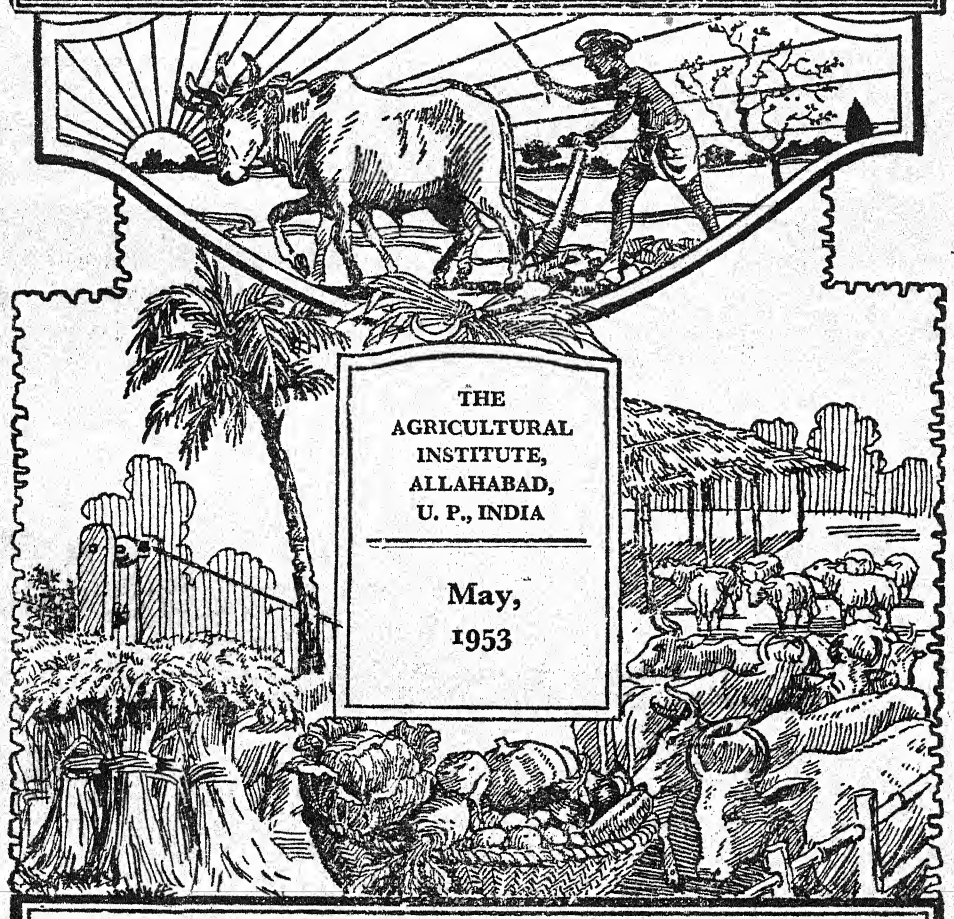

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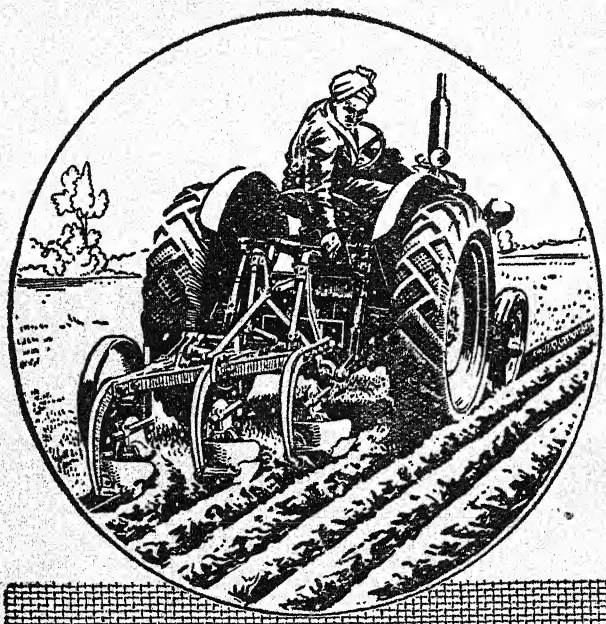

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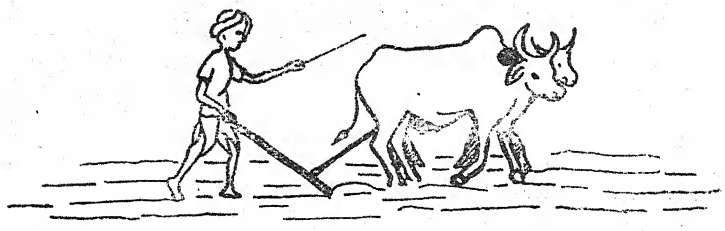

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NITRIFICATION IN KANPUR SOILS *

By

DR. A. N. PATHAK, SOIL MICROBIOLOGIST BIHAR, SABOUR

Nitrification may be defined as a process of oxidation by which ammonia is converted first into nitrite and then into nitrate through the action of bacteria. The capacity of a soil to oxidise ammonia to nitrite and finally to nitrate is termed its 'nitrifying capacity' or 'nitrifying power'. The two groups of nitrifying organism concerned in the process are classed as Nitrosomonas and Nitrosococcus, and Nitrobacter; the former two oxidise ammonia to nitrite and the latter oxidises nitrite to nitrate. They are specific in their action.

Several investigators have pointed out a positive correlation between the nitrifying power of a soil and its productivity. According to Brown (1915) (1916) and Lipman (1917) there is a direct relationship between the nitrifying capacity and fertility of the soil. Vogel (1910) demonsrated a direct proportion between the yield of potato and barley and the nitrifying capacity of the soil. Burgess (1918) considers nitrification as an important biological test for predicting the probable fertility of Hawaian soil.

But others, notably Jensen (1916) and Banazzi (1915) have reported that the nitrifying capacity of a soil may or may not be correlated with its crop-producing power and that continuous cropping, specially without manuring, was found to reduce the nitrifying power of the soil. On the other hand Pathak and Shrikhande (1952) observed that unmanured soil showed a greater degree of nitrification than manured soil. They also studied the effect of different mechanical fractions on nitrification and found that all the three fractions from the unmanured plot encouraged

* Part of a thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the University of Agra, U. P.

greater nitrification than the corresponding fractions from the manured plot and that clay possessed the greatest nitrifying capacity of all the fractions.

Waksman (1923) states "When we compare the nitrifying capacity of two soils by the common method of adding ammonium sulphate (much in excess of what we would add to field soil) to 100 gm. of soil and determine the nitrate formed after incubation, we actually measure not only the nitrifying capacities of two soils, but merely in a round about way, the initial reaction, buffer content and presence of neutralizing substances of the soil.

With the assumption that the nitrifying capacity of a continuously cropped soil without manuring goes on decreasing gradually, there would be bound to be less nitrate formation with cropping. This would naturally affect the crop yield. Although there seems to be a low yield from the fields which receive practically no manure, yet the soils in several instances have been found to give a constant yield of crop year after year. This applies to the unmanured wheat plot under experiment. Naturally the question comes as to how these observations fit in with the constant yields on alluvial soil ?

Soils for this investigation were obtained from the permanent manured and unmanured experimental plots of the Government Agricultural College, Kanpur Farm which were started in 1885 and continued till 1920 when the manurial experiments were discontinued except for the cow dung plot. The unmanured plot, however, was left untouched for continuous growing of wheat without manuring. The chemical and physical nature of the soil has been discussed in detail by Shrikhande and Pathak (1925).

The nitrifying capacity of surface soil from both the plots was, therefore, investigated under controlled conditions. Samples of 100 gm. each were incubated in erlenmayer flasks at 30°C with eight replications. Nutrients were added in such amounts as are usually present in 100 c. c. of Winogradsky medium*. The moisture content of the flasks was maintained at 15%. After one month's incubation, the nitrate was determined by the phenol-disulphonic acid method. The results are reported in-parts per million in tables 1 and 2.

TABLE 1

Nitrifying capacity of soils 1948-49.

Months	MANURED			UNMANURED			
	NO_3-N in soil ppm	NO_3-N after incubation ppm	Gain in NO_3-N ppm	NO_3-N in soil ppm	NO_3-N after incubation ppm	Gain in NO_3-N ppm	Excess NO_3-N in unmanured over manured soil. ppm
Aug. 48	3.1	121.8	118.7±4.1	3.9	143.4	139.5±4.7	20.8
Sept.	4.7	176.4	171.7±3.2	4.1	188.7	184.6±3.4	12.9
Oct.	8.2	213.5	205.3±5.9	7.4	271.7	264.3±3.3	59.0
Nov.	3.9	213.3	209.4±4.4	3.7	276.9	273.2±4.1	63.8

Dec.	3.9	132.0	128.1 ±4.7	3.2	178.7	175.5 ±4.5	47.4
Jan. 49	2.8	123.3	120.5 ±4.1	2.7	155.5	152.8 ±5.1	32.3
Feb.	3.1	122.1	119.0 ±4.2	3.1	147.7	141.7 ±5.2	25.7
March	5.0	185.6	180.6 ±5.1	4.7	197.7	193.0 ±4.9	12.4
April	9.7	375.9	366.2 ±4.3	8.9	406.2	397.3 ±4.9	31.1
May	9.3	350.6	341.3 ±5.4	8.7	388.7	380.0 ±5.9	38.7
June	6.9	343.4	336.5 ±5.9	6.5	383.2	376.7 ±4.1	40.2
July	3.1	110.7	107.6 ±5 6	3.1	134.9	132.2 ±5.7	25.6

* $(NH_4)\,SO_4$ .....1.0 gm
$K_2\,HPO_4$ .....1.0 gm
NaCl .....2.0 gm
$MgSO_4\,7H_2O$ .....0.5 gm
$FeSO_4 . 7H_2O$.....Trace
$MgCO_3$ .....20.0 gm
Distilled water .....1 litre

TABLE 2

Nitrifying Capacity of Soils, 1949-50

	Manured			Unmanured			
Months	NO_3—N in soil ppm	NO_3—N after incubation ppm	Gain in NO_3—N ppm	NO_3—N in soil ppm	NO_3—N After incubation ppm	Gain in NO_3—N ppm	Excess NO_3–N in unmanured over manured soil ppm
Aug. 49	2.0	119.3	117.3 ±3.9	1.0	136.8	135.8 ±3.4	18.5
Sept.	2.5	175.3	172.8 ±3.7	1.7	189.4	187.7 ±3.1	14.9
Oct.	6.3	208.7	202.4 ±4.2	3.3	231.6	227.3 ±4.9	24.9
Nov.	4.1	247.4	243.3 ±4.4	2.1	289.6	287.5 ±4.3	44.2
Dec.	2.6	162.5	159.9 ±4.1	2.3	199.8	197.5 ±4.7	37.6
Jan. 50	2.8	123.3	120.5 ±4.7	1.9	147.8	145.9 ±5.1	25.4
Feb.	3.4	88.6	85.2 ±3.1	2.4	108.1	105.7 ±4.2	20.5
March	3.3	190.0	184.7 ±5.1	2.6	199.9	197.3 ±5.1	12.6
April	7.6	349.3	341.7 ±4.9	5.0	380.9	375.9 ±4.5	34.2
May	8.3	347.2	338.9 ±4.8	6.2	387.6	381.4 ±4.3	42.5

It may be seen from the results in tables 1 and 2 that the nitrifying capacity of the soils was highest during the summer months. In samples of soil collected during the rains, however, there was a considerable decrease in the physiological activity of the nitrifying organisms which may be due to the seasonal variation as pointed out by Whiting and Schoonover (1920). Higher amounts of nitrate during the period October to January indicate that the nitrifying power of the soil during crop growth is fairly high. It is highest at the time of sowing and tillering, i. e. when the crop needs it most. The higher nitrifying capacity coupled with the amount of nitrate dissolved in water brought up from the sub-soil by the capillarity of the soil helps crop growth. When these points are compared for the manured and unmanured plots, there is a greater percentage of nitrate available with respect to the total nitrogen content during crop growth for the unmanured plot.

This suggests that the continuous cropping without manuring had in no way adversely affected the nitrifying capacity of bacteria of the unmanured plot. On the other hand they prove more efficient in producing nitrate than corresponding organisms in the manured plot. But, as no manure was added to this plot, there is bound to be a low crop yield (actual yields of the manured and unmanured plots have been compiled by Shrikhande and Pathak 1952). It is all the more interesting to note that the yield of wheat is not going down yearly; rather there is a steady crop yield which may be due to the efficiency of nitrifying organisms of the unmanured plot which are capable of nitrifying the soil nitrogen present in it.

Nitrification tests were conducted in the various mechanical fractions and their mixture to test their effect on nitrifying power. This was determined by adding 2 grams of the different fractions to 100 c. c. of Winogradsky medium. The joint effect of these fractions on nitrification was studied by mixing two grams of them in the same proportion as they existed in the soil. The medium, after inoculation with a pure culture of the nitrifying organisms, was incubated for a fortnight. After incubation, the medium was analysed for nitrate content. The results in parts per million are incorporated in tables 3 and 4.

TABLE 3

Nitrifying power of different mechanical fractions separately.

NO_3—N in ppm

	Manured			Unmanured		
Fractions	0″ – 6″	6″ – 1′	1′ – 2′	0″ – 6″	6″ – 1′	1′ – 2′
Clay	8.02	6.96	5.15	9.52	8.39	6.12
Silt	5.10	4.39	3.11	6.93	6.74	3.59
Sand	3.75	3.12	2.93	4.12	3.57	2.63

TABLE 4

Nitrifying power of different mechanical fractions jointly

NO_3—N in ppm

	Manured			Unmanured		
Fractions	0″ – 6″	6″ – 1′	1′ – 2′	0″ – 6″	6″ – 1′	1′ – 2′
Sand + slit	4.25	4.10	3.00	5.31	4.97	3.11
Slit + clay	4.95	4.53	3.27	6.29	6.00	4.39
Slit + sand	5.25	5.11	4.05	6.79	6.95	5.41
Sand + slit + clay.	6.97	5.93	4.99	7.87	7.74	6.05

It is apparent from these results that as in the case of nitrogen fixation (Pathak, Shrikhande, and Mukerji 1951), the finely divided fraction has some physiological influence on nitrification. This phenomenon may be due to the greater surface exposed for the absorption of the nutrients. It appears that these fractions aid in nitrification by replenishing ions in the medium when they are removed by the growing organisms.

All the three mechanical fractions in general, from the unmanured plot encouraged greater nitrification than the corresponding fractions from the manured plot, clay definitely possessing greater nitrifying capacity than slit and sand in both the soils. The surface soil indicated higher activity in both the plots. When these fractions were mixed in the same proportion as they occur in soil, the maximum amount of nitrate was found when all the three, viz. sand, slit, and clay were present. Hence the continuous growing of wheat without manure appears to have modified the nitrifying capacity of the soil as a whole and also of the individual fractions, so that the various mechanical fractions enhanced the efficiency of nitrate producers in the unmanured soil as compared to those from the soils which are regularly manured and cropped.

Summary

The nitrifying capacity of manured and unmanured soils of the Kanpur Farm was tested for the years 1948-49 and 1949-50. It was observed that there were two maxima in nitrification, one during October-November and the other during summer, with the highest nitrification during April. The unmanured soil has a greater nitrifying capacity than the manured one. Clay encouraged greater nitrification than slit and sand in both the soils. All the three mechanical fractions from the unmanured plot encouraged greater nitrification than the corresponding fractions from the manured plot. A combination of all the three fractions, viz. sand, slit, and clay in the same proportion as they occur in soil, gave greater nitrification than any combination of two of the three fractions.

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ANNOUNCEMENT

Prizes for Christian Authors on Social Concerns:

The Committee on Special Literature wants to encourage Christian Authors to write on Social Concerns for the benefit of village congregations and is offering prizes of Rs. 50 each for the best pamphlets.

The following are the rules:—

1. The pamphlets should be written on any one of the following subjects:—
   (i) The Christian and caste. (ii) The social responsibility of local congregations. (iii) The Christian attitude to land. (iv) The Christian attitude to unemployment. (v) The Christian role in politics.
2. The pamphlets may be written in any one of the following languages:—

English, Tamil, Malayalm, Kannada, Telgu, Hindi, Bengali, Marathi, Gujarati, Oriya, Punjabi, Urdu.

3. The pamphlets must be written for the village level readers of each language area. The English pamphlets may be for the High School-level readers.
4. The length of the pamphlet shall be between 2,000 and 3,000 words.
5. One prize of Rs. 50 may be awarded for each subject in each language.
6. There will be a Board of Judges in each language, whose decision shall be accepted as final.
7. Unless the pamphlets reach a certain standard of quality the Judges may decide not to award any prizes.
8. The prize-winning essays will belong to the Special Committee, which will arrange for the publication. Unless specially requested and postage sent, the copies of essays will not be returned to the authors.
9. Authors who join the competition should certify that their work is original and has not appeared in print before.
10. The manuscript, either type-written or very legibly written by hand, should be sent to the Secretary of the Special Literature Committee, not later than 31st December 1953.

Rev. J. R. Chandran,
Secretary,
Special Literature Committee.

United Theological College,
17, Miller's Road,
Bangalore 1.
September 19, 1953.

WHEN TO HARVEST MAIZE FOR FODDER

By

G. H. DUNGAN*

Maize plants do not grow in height after tasseling. This is sometimes interpreted as indicating that the plants have stopped growing. Acting on this assumption some growers harvest their maize for fodder soon after its tassels emerge. To do this is a sad mistake. The purpose of this brief article is to set forth reasons for delaying the harvest of fodder maize until after the grain is well along toward maturity.

Up to the time of tasseling and silking maize plants have utilized their energy in the production of roots, stems, leaves, tassels and embryonic ear shoots. At tasseling time the surface of the leaves has reached its maximum. If leaves were the object of growing the crop, the plants might as well be harvested at this time. But it happens that leaves can do more than provide the forage which is contained in their tissues. They have an important work to do. They constitute a factory for synthesizing feed materials. If the crop is harvested before the leaves have fulfilled their function the farm operator loses greatly.

Growers of maize for grain understand this principle very well. They consider that all their efforts in plowing, planting and tilling up to silking time are for the purpose of enabling the maize plant to establish itself in the soil and in the air. They are, as it were, building a grain production factory and at pollen-shedding time the factory is ready to start its wheels rolling.

If the plants are allowed to remain unharvested and if conditions of growth are favorable, the wheels of this grain factory will continue to roll. Under ideal conditions they will stop only when there is no place to store the product they manufacture. That is to say, proteins, fats, and carbohydrates will be elaborated, translocated and packed into the kernels until the ovary well of the pericarp will permit no further addition.

At this stage of plant development the husks of the ear have begun to dry up, as have also, the lower blades of the stalk. The blades on a level with the ear and those above the ear are still green and fresh. The moisture content of the grain is about 35 percent.

Along with this filling of the kernels goes a marked increase in yield per acre. Field tests have shown that from the early silk stage until the ears are completely ripe, the gain in dry matter is usually more than 100 percent. Not only is the increase in weight very great, but it is also very rapid. The plants have their maximum leaf surface at this time and all of the product of their synthesis, except that used to carry on life processes, can be stored as reserves in the kernels.

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Another point to bear in mind is that the gain in yield is made up of materials having high feeding value. Analyses at the Michigan Agricultural Experiment Station showed that between tasseling and kernel denting the yield of protein per acre advanced from 473 to 711 pounds. The nitrogen-free extract per acre increased from 1,828 to 4,554 pounds; and the fat from 68 to 199 pounds. The Maine station found that the pounds of sugar and starch increased from 358 to 2,244 as the plants advanced from the beginning of ear formation to the beginning of kernel denting. Of course, there is an increase in fiber which has a low feeding value, but the increase in fiber is much less than is that of the desirable constituents.

Therefore, to get the maximum quantity and quality of feed from a maize fodder field, let the plants attain a good ear development before harvesting them. This will require about a month's time after the shoots come into silk. The amount of development will depend upon the conditions of growth being favourable.

Now, having presented arguments in favour of harvesting fodder maize after ear development is well along, let us look at reasons which justify the harvest of maize at silking time. In the first place, if the available fertility in the soil is so low that plant growth is restricted, ear growth will not take place. Nitrates are low in many soils. This is indicated by light-green blades all over the plant and by the yellowing of lower blades with a dying back from the blade tip along the midrib. So, unless the plants are dark green and healthy looking, you might as well cut them for fodder when they are in the fresh-silk stage.

Another matter affecting the economy of delayed harvest of fodder maize relates to the protection that can be given the crop. Grain eating birds, such as crows, are very fond of the soft sweet kernels. These must be kept out of the fields. Unless this can be done, go ahead and harvest the crop early. The same may be said with respect to jackals. These animals relish the milky kernels and they can consume many acres of valuable maize. The injury done by jackals is often more serious than that done by crows because the jackals break over the plants, whereas the birds eat the grain off the cobs and let the stalks stand.

Therefore, in order to get the most from maize as fodder:—

1. Postpone harvest until the ears are well filled because the grain constitutes the most important part of the crop.
2. Supply fertility in the soils so the plants do not have a deficiency of plant food.
3. Eliminate the hazard of pests by a program leading to their extermination.

ANNOUNCEMENT

The Indian Dairy Science Association has organised an Essay Contest open to all *Bona Fide* students of dairy, agricultural, veterinary and other educational institutions and research institutes. The subject of the essay is "Application of Refrigeration in Improving the Dairy Trade in India." The essays must be written in English, not exceeding 3,000 words, and three typed copies must be sent to the Association before 15th January, 1954. Further particulars about the contest can be obtained from the Hon. Secretaries, Indian Dairy Science Associations, Hosur Road, Bangalore 1.

HETEROSIS

By

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Offspring resulting from crossing inbred parents frequently exhibit unusual vigor. This phenomenon is commonly referred to as "*hybrid vigor.*" Its occurrence has been observed by many workers. Hybrid vigor was noticed by Kolreuter as early as the eighteenth century, Gartner and Weigmann observed it in nineteenth century. Shull (1914) coined the term, "heterosis", for hybrid vigor. It refers to the growth stimulus resulting from the union of unlike gametes.

Various hypotheses have been advanced to explain heterosis. The purpose of this article is to summarize the theories that have been presented by leading geneticists of the world to account for this phenomenon.

Physiologic Stimulus Hypothesis.

East and Hayes (1912) and Shull (1910) proposed a non-Mendelian hypothesis to the effect that heterosis was due to some kind of physiologic stimulus resulting from the union of dissimilar gametes. They observed that a greater developmental stimulus was obtained when the mate of the allelomorphic pair was lacking than when both were present in the zygote. That is, when like genes are present in the zygote, the growth stimulus is less than when unlike genes are present. The decrease in vigor due to inbreeding and the increase in vigor due to crossing are manifestations of the same phenomenon. Inbreeding is not injurious in itself, for the weak individuals kept in existence in a cross-pollinated species are isolated. In self-fertilised species weak plants may appear as a result of mutation but they are eliminated automatically since they cannot compete successfully with the more vigorous members of the population.

Greater Initial Capital Hypothesis

Ashby (1930) attributed the better performance of the hybrid to greater embryo size which he termed as "greater initial capital". The F 1 hybrids had an increased percentage of germination and a vigorous growth in the early stages which gave them an advantage that was maintained throughout the grand period of growth. He pointed out that the relative growth rate of the better parent was inherited in the same manner as a dominant Mendelian factor. Hybrid vigor according to him was nothing more than the maintenance of the initial advantage derived from having a large embryo. Attributing the phenomenon to a simple Mendelian dominant seems an over-simplification of the problem. His suggestions though quite valuable did not present the whole story. Ashby recoganized this himself, for although he at one time believed the greater embryo size to be the cause of hybrid vigor, later he attributed the vigor to the greater amount of meristematic tissues in the hybrids.

Various crosses including the reciprocal ones were made by East (1936b) in peas, beans, and other crops. He did not get any correlation between seed size and heterosis for the F 1 seed was not greater in weight than that of either parent. But even so; an increase in size of embryo and endosperm in itself is a phenomenon of heterosis.

A second objection to Ashby's hypothesis grows out of the fact that F 2 seeds are larger than the F 1, but the overall growth is inferior to that of F 1 plants.

Lindstorm (1935) cut back the F 1 plants in an attempt to counteract the advantage of greater initial capital, and still there was an increase in yield over the parents.

In case of animals, it is difficult to imagine how cross-fertilised eggs could show more initial capital than the line-fertilised one. Also, a sexually propagated plants maintain their F 1 vigor through many seasons of growth.

Sprague (1936) observed a rapid growth rate in Maize hybrids during germination and the early seedling stage but not from the late seedling stage to maturity.

Dominant Favourable Gene Hypothesis

The most widely accepted explanation for heterosis is that of dominant genes. One homozygous line has a certain set of the favourable genes. Another line contains another set of favourable genes which complement those in the first line. The heterosis in hybrids results from bringing together of these complementary dominant genes from two parents. The deleterious effects of the recessives are covered up by the dominant favourable genes.

Keeble and Pellow (1910) produced the first Mendelian explanation for heterosis. They explained it on the basis of two pairs of dominant factors. In a pea cross, they observed the F 1 hybrids inherited the greater node number of one parent and the longer internode of the other. Thus, the greater growth resulted from the bringing together of the two dominant factor pairs from the two parents.

Bruce (1910) offered a similar Mendelian explanation of hybrid vigor from a purely mathematical point of view.

The validity of this hypothesis has been questioned by many workers. For instance, vigorous hybrids have been obtained from crosses between two dwarf lines. Other objections are based on the fact that, firstly, if only two pairs of factors are concerned, a line could be obtained in the segregating generation which would be homozygous for the two dominant factor-pairs and at the same time breed true for the vigor of the F 1 hybrid. No such case has been discovered so far. Secondly, in case of dominance, the F 2 distribution would be skewed. That, too, has not been found.

To account for the objections raised against the dominance hypothesis, Jones (1917) put forward the hypothesis of linkage of dominant favourable genes. A large number of genes are concerned with heterosis. Naturally it is not possible to combine them all in one line as linkage with

deleterious recessive is bound to occur. Singleton calculated that with 30 pairs of factors having no linkage amongst them, one would need about 2000 times the earth's area, to grow and recover all of them in one line of maize.

Collins (1921) said that it was not necessary to assume linkage to explain the absence of skewed distribution in F 2. If as many as 20 pairs of factors were involved with complete dominance of each and a cumulative effect of one on the other, skewness in F 2 would not be evident. With more pairs of factors, linkage is bound to occur and complicate the recovery.

Richey (1927) and Richey and Sprague (1913) have presented data on convergent improvement in maize. In this method, the two lines namely A and B of a single cross, (A×B) are improved by the back-cross method of breeding, without changing their specific combining ability. This consists of back-crossing the F 1 hybrids, that is, (A×B) to both the parents A and B in two regular series. The back-crossing is done a couple of times, selecting in each generation the favourable factors of the non-recurrent parents and then selfing is done at the end to produce homozygosis. It amounts to shovelling over of dominant favourable genes from A to B and from B to A, with the result that the improved A and B perform better in crosses than the original A and B. This result has given additional support to the "dominance theory". It has been suggested that a greater yield is possible when dominance is only partial and not complete.

Superiority of Heterozygote Hypothesis

East (1936b) proposed that vigor-genes consisted of a series of alleles the function of which diverged in varying degrees. The divergent alleles when present together interact to produce an effect which would exceed either of the alleles when present in a homozygous condition. Hull's (1945) hypothesis of overdominance seems to be due to heterozygosity exceeding in function to that of either homozygote. In the heterozygous condition, recessive lethals do not have as deleterious effect as they would if they were in a homozygous condition.

Autotetraploids produced in maize inbreds have been found to be inferior to related diploids whereas autotetraploids from F 1 hybrids are superior. This has led some to conclude that heterozygosity itself is responsible for much of the vigor expressed by the hybrids.

It has also been suggested that genes for quantitative characters have different interactions in homozygous condition from those in heterozygous condition.

Criticism of the hypothesis of allelic interaction have been based chiefly on the following.

(1) The existence of an allelic series of genes which condition numerous physiological characters has not been demonstrated, In reply to this criticism it may be said that genes concerned with physiological processes have been less studied in comparison with the genes conditioning morphological characters. When genes are studied under a variety of conditions, isalleles may be found to occur. This may be expected with the extensive study of the genes involved in physiological processes.

Also, it is not necessary to assume an extensive multiple-allelic series. Two alleles at each locus may be sufficient.

(2) There is not much evidence to support the assumption that different alleles of the same series condition different processes which in combination would produce some kind of complementary action.

This criticism may have some validity. However, heterosis may result from separate complementary or additive effect of both the alleles. Glaring cases have been met, *e. g.* coat-colour in cattle, pericarp-colour, and pericarp and cob-colour in maize which are given below.

Parents	*F* 1 *hybride*
1. Short-horn red × Short-horn white cattle	Roan cattle—with both red and white coat colour expressed in the same cattle.
2. Stippled pericarp × Navajo pericarp	Stippled and Navajo both present on the same kernel.
3. White cob with red pericarp × red cob with white pericarp.	Red cob with red pericarp.

Heterotic effects of two alleles in the heterozygous condition have been quite small in general and significant differences have been difficult to establish. Probably, a large number of genes reacting in this manner, would give a greater total effect.

The lack of agreement between various studies indicates the heterosis is manifested in various ways in different hybrids. It may be due to various causes. For plant breeders, the dominance hypothesis of linked growth factors provides a workable basis for an attack on the problem.

How To Measure Heterosis

There is no definite yard-stick to measure heterosis. Many measures have been followed. The most common is the comparison of the F 1 with the performance of the two parents, either the average of the two parents or the larger of the two being selected as the base. In plant breeding studies, the open pollinated varieties from which the lines have been derived would serve as standards. Amongst the sexually propagated plants, the clones from which the inbreds have been derived or which have been used in crossing may be taken as standards.

Heterosis And Genetic Diversity.

There exists a close relationship between genetic diversity and hybrid vigor. Most of the laws governing the production of hybrid maize were known to people long before its production reached commercial significance. The main reason was that the people did not know the value of making unrelated crosses.

Heterosis And Inbreeding Depression.

Plant species differ in their response to inbreeding. The three classes and their heterotic responses are as follows:—

(1) *Normally cross-pollinated crops*—Maize is one of the best known crops in the group. Inbreeding invaribly produces reduction in

vigor and size of the inbred. No single inbred is known whose performance comes up to the standard of the open-pollinated variety.

Amongst forage crops, *e. g.* grasses and legumes, reduction in vigor differs widely among families. In some cases inbreds have been obtained which conform to the standard of the open pollinated varieties. In general there is a less universal vigor depression than in maize. However, crosses between inbreds produce considerable hybrid vigor. In alfalfa crosses between the non-inbreds frequently produce vigor exceeding that of the parental clones. There is an increase in the yield of forage and seed. This may well indicate the differences between the species in concentration of the vigor genes.

(2) *Normally self-pollinated crops:*—This includes cereals, beans, and tomatoes. Homozygous inbreds are normal and vigorous. There is no reduction in vigor due to inbreeding and at the same time, heterosis is associated with little or no vigor. In tomatoes, the advantage rarely reaches fifty percent and heterosis occurs only once in a number of crosses.

(3) *Species in which both cross and self-pollination occurs:*—Sorghum has been intensively investigated. Relatively homozygous lines have been obtained without any loss of vigor. In hybrids between unrelated varieties considerable heterosis is evidenced.

Heterosis In Practical Crop Improvement.

Heterosis is being utilised in the following crops:—

Farm crops: Maize, sugarbeets, sorghums forage legumes and grasses.

Horticultural crops: Tomatoes, squashes, cucumbers, egg-plant onions, and annual ornamentals,

Live Stock: Swine, poultry, beef and dairy cattle, and silk-worms.

Medical plants: Penicillin.

Heterosis is a vital issue before the breeders. Endless efforts are still being made to reveal more facts about it. However, one has to work on the most tangible basis discovered so far.

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SOWING SUGARCANE WITH GRAM OR PEAS

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"Food shortage", a by-word of the day, has become a vexing problem as much for the responsible men in offices as for a man in the street and on the land. The people at the helm of affairs have strained their nerves to the utmost, but the problem does not seem to be coming under control. The more we have thought of it and worked for it, the more it has defied our solution. The danger of famine has ever been hanging over our heads like the sword of Damocles. I will be failing in my duty if I do not pay due tribute to the leaders who have flown through such a stormy and threatening atmosphere of the last five years. The storm has not completely blown over and our efforts to combat the catastrophic situation of food shortage seem to be futile. It is really as surprising as regretable that a country like India, gifted with so much national wealth and resources, should go begging food from other nations. Our efforts aimed at self-sufficiency have not borne the desired fruits and nature herself seems to be unconcerned with our struggling for life. I wish to put before the readers a suggestion which, in my humble opinion, can greatly help the Grow-More-Food campaign. I find in intensive farming a way to help make the campaign a success.

There is no doubt that the area under sugarcane has increased much during the past few years due to high prices of sugar. This has considerably reduced the area under other food crops. The Government tried to devise ways and means to restrict the increase of area under sugarcane cultivation, but failed.

By adopting a system of growing sugarcane as a mixed crop with gram or peas, the area under these food crops will increase in proportion to the area under sugarcane. This is not a fresh suggestion but is being practically followed in Saharanpur, Muzaffarnagar, and Meerut districts and is gaining popularity progressively.

Sugarcane is ordinarily sown after taking some *kharif* crop, such as *sanai*, *guar*, other pulses, and maize. In combination with *sanai*, either as a turned-down crop for green manuring or as a crop allowed to mature for seed, the time required is very great, a year and a half. From July to February is used for preparation and from February to the next February is required for growing. The cultivators cannot afford to keep their fields fallow for two consecutive seasons in order to plant sugarcane in February. If sugarcane is sown after other *kharif* crops, then too the growing season is long enough *i.e.*, from October to February for preparation and a full year for growing. Cultivators used to take sugarcane after gram or peas in March and April, when indigenous varieties were grown. Improved varieties do not do well if sown late in March or April, after gram and peas are harvested. The practical difficulty for the cultivators, therefore, has been that suggarcane, if sown after gram or peas, is very late and if the fields are left fallow during the *rabi* season for sugarcane planting early

in February, they have to forego a *rabi* crop. This difficulty has its solution in planting sugarcane with the gram or peas early in the month of October which is the best time for growing gram.

Preparation for sowing sugarcane mixed with gram or peas:

Fields for planting gram are not prepared even half as thoroughly as for wheat. This is perhaps for the reason that gram is sown quite early in the season and fine preparation may delay its sowing. Secondly gram, being a deep-rooted crop, can manage to establish itself in the soil even if the field is ploughed only once or twice. But for growing gram as a mixture with sugarcane, fields are as finely cultivated as for wheat, because gram and sugarcane are diametrically opposite in their water requirements. Gram requires ordinarily no irrigation while sugarcane needs many. Thorough preparation of the field will maintain moisture enough for the germination of both the crops as well as conserve it for further growth of the crops till there are some rains in the winter season.

Proper time for sowing:

The crops should be sown early in the season, when it is the proper time for sowing gram. Early sowing is advantageous in that high temperature is helpful in the germination of sugarcane buds. If it is sown late when the temperature is low, sugarcane will fail to germinate fully.

Seed:

Sugarcane stems do not mature fully early in the month of October. Therefore sets for sowing are taken from a ratoon crop which is almost matured at this stage. A rather high seed-rate *i.e.*, sixty maunds per acre is desirable to ensure a normal thick crop, as many buds may fail to germinate.

Methods of sowing:

When the field is prepared sugarcane and gram can be sown in the following ways:—

1. If there is enough moisture, gram should be scattered in the field and be mixed by ploughing once and covered and levelled with *pata*. The next day sugarcane should be sown in lines three feet apart as usual.

2. Gram and sugarcane can be sown simultaneously with the help of three ploughs. Sugarcane is planted in the first furrow and gram in the next two, sugarcane in the fourth and gram in the fifth and sixths and so on.

3. Gram should be drilled and the next day sugarcane be planted in the usual way.

Irrigation:

In a thoroughly cultivated field the crops do not require any irrigation till gram is harvested if there are enough winter rains, but one irriga-

tion late in December is necessary if winter rains fail. Of course irrigation near the flowering time is harmful.

Harvesting of gram:

After complete maturity gram is harvested and the field is at once irrigated. This irrigation comes as a boon to the sugarcane crop. The dead leaves of the gram, which are usually left in the field, are covered and mixed with the soil by using a cultivator in between the lines. The sugarcane plants after watering make a quick start, and within a fortnight, with a well established root system grow unexpectedly tall and healthy. This cane, which is by now six months old will ever remain stout, tall and vigorous. It faces no danger from early heavy rains because by the time, the rains begin it will be tall and healthy enough to withstand all severities of the weather.

Yield per acre:

The sugarcane crop with a little manuring after the harvest of gram can give six hundred to eight hundred maunds of cane per acre and with heavy manuring about one thousand. Even if no manure is given, we can expect about six hundred maunds of cane. Then with little or no extra expense one secures twenty maunds of gram in addition. The gram under this system grows extraordinarily tall and becomes so bushy as to cover the small sugarcane plants, protecting them from the effect of frost. Because of better cultivation the gram grows luxuriouly and sheds a large amount of dead leaves which enrich the soil to the extent that six hundred maunds or more of sugarcane per acre becomes possible.

One great difficulty in this system is that in October the cultivators are too busy with *rabi* preparations and they cannot spare time for planting sugarcane. Still if the scheme can materialize it will go a long way to solve our food problem. The total area under sugarcane in Uttar Pradesh in the year 1948-49 was 2,102,000 acres and in the Indian Union 3,645,000 acres. If even one-half of this area can adopt the system, it can produce a large tonnage of food grains, which may suffice for our requirements.

THE CULTIVATION OF PARWAL

By

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1. **Introduction:**— Green vegetables are essential in the diets of people in India where the population is predominantly vegetarian. Minerals and vitamins which are important for health can be cheaply and easily secured from the green vegetables. And by increasing vegetable consumption we can economically minimise the consumption of food grains which would prove of great help to the nation during the present food crisis. Thus attention toward the production of better kinds of vegetables like *parwal* will not be out of place. *Parwal* is one of the most nutritive and wholesome vegetables, and is very useful for the convalescent. It is called the king of vegetables. Its Hindi name is *parwal* or *palwal*, its Bengali name *patal* or *potol*, and its botanical name *Trichosanthes dioica* Roxb. In English it is sometimes called green gourd.

2. **Description of the plant:**— *Parwal* belongs to the gourd family Cucurbitaceae. The plants are perennial, diocious, with tuberous roots. The stem is a tendril climber and the tendril is forked. The leaves are ovate cordate, 3″ x 2″, with a deep sinus, and denticulate margins, and a petiole 5″ - 1. 5″, hispid and hairy. The flowers are all axillary. The male flowers are often paired, one short, the other long, and peduncled, The corolla is white fringed (hairy), There are three stamens. The female flowers are short peduncled, 1. 5″ long, a glandular bract is present at the base of peduncle; and the sepals are oblong-lanceolate, 0. 2″ long. The fruit is 2″ - 3. 5″ or 4 ″ (in cultivation) long, oblong, hairy, and orange when ripe. The seeds are .3″ - .5″ long a little compressed with a slightly corrugated margin, and are dark brown.

Pollination is done by small beetles which carry pollen grains from the male plants sometimes for miles, and pollinate the female flowers.

3. **Origin and home:**— The views of the various workers regarding the original home of the genus *Trichosanthes* to which *parwal* belongs are as follows:—

Roxburgh (1832), as quoted by Hooker (1879) (6), states Bengal to be the original home of *parwal*. De Candolle (1884) established it to be India and the Malayan archipelago (3), Duthie and Fuller (1883) have written in their "Flora of Upper Gangetic Plain" that India or the Indian archipelago is the home of *Trichosanthes* species (4). Whitaker (1933) is of opinion that South East Asia, the East Indies and Australia are the native places of *Trichosanthes* species (10).

Investigations have shown that the genus is confined to tropical Asia, North Australia, and Polynesia. Out of 58 species traced in the world so far 28 species are found in India alone (1,8).

4. **Distribution in India and centres of its cultivation**:— The wild forms of *parwal* are found throughout the plains of North India from the Punjab to Assam and East Bengal. But its cultivation is confined to the Gangetic plains of eastern U. P., Bihar, East Bengal, and Assam (5, 6).

5. **Climate**:—It requires a humid climate and grows well during the hotter part of the year from March to October. During the cool winter months the crop does not bear fruit nor is there much vegetative growth.

6. **Soil**:—High, well drained land is best for its cultivation. It dislikes stagnant moisture at the roots. A crop sown in low lying river beds may get submerged when the river is in spate and the entire lot destroyed.

7. **Manures**:—Cultivators growing *parwal* in the beds of rivers generally do not apply any manure, but well-rotten cow-dung at the rate of 2 to 2½ seers per plant should be given to secure more and better fruits.

8. **Varieties**:—The varieties are distinguished on the basis of fruit shape, size, colour, and structure. The following are the important cultivated varieties (8, 9):---

(i) Long green, with rough surface, tapering towards both ends, 4. 0″ by 2″ in size.

(ii) Long, green, spindle-shaped with dark green stripes 4. 0″ by 1. 6″ in size.

(iii) Light green, smooth, conical, 3. 5″ by 1. 5″ in size.

(iv) Light green, oval or globular 3. 4″ by 1. 5″.

9. **Time of sowing**:--- *Early* - February to April.

Late - May to July,

10. **Rotation and cultural practices** :—*Parwal* is generally sown as a mixed crop in winter with wheat, barley, or gram in diara lands (rich alluvial soils in the river beds). The planting is done in the fields after the *rabi* crops have been sown in them. It is also sown with betel, *pan*, (*piper betel*) inside the thatched shelters provided for the latter. (2) Planting is done beside the irrigation channels at 20 'to 30' and the vines are trained to spread over the thatch. The vines protect the betel from the sun and heat and also provide vegetables for the market. After the *rabi* crops are harvested the *parwal* is seen growing rapidly in the harvested fields.

In the rainy sesson when the flood water enters the *parwal* fields, the cultivators prepare *guchchi* (vine in coils) and carry them to higher places for replanting. The practice of planting a new crop each year in the *rabi* fields is economical. But for *betel* fields and kitchen garden s plantings they remain economical for two or three years, after which they should be replanted.

11. **Preparation of land for sowing:**—*Parwal* is generally sown in thalas (pits) at distances of 8 feet apart. Pits are dug 1′ by 1½′. They should be filled with 2 to 2½ seers of cow dung manure mixed with soil about a fortnight before planting and this is followed by two irrigations and two hoeings, one after each irrigation so as to mix the manure in the soil properly.

12. **Methods of Propagation:**—Propagation is generally done by stem cuttings. If it is propagated by seeds, it takes about 10 or 11 months for primary vegetative growth when it starts bearing fruit. Moreover, the number of males in the seed sown crop is much more than is desirable. The male and female plants are not distinguishable till flowering. The seed-sown crop proves uneconomical. The cultivators believe that *parwal* cannot be propagated by seeds. But when the author sowed seeds of *parwal*, they germinated and gave plants. One-year-old seeds were sown in the month of May this year. They germinated within 10 days. The fresh seeds were also taken from the fully ripe fruits, and sown on the same day. They germinated within 15 days. They have no dormancy; fresh seeds from the ripe fruits germinate normally. Their germination percentage was noted, and it was above ninety, and in some cases up to one hundred. The plants from the seed are very thin, with small leaves, and their growth is very slow. They will not bear fruit before the following April or May, after completing necessary vegetative growth.

Propagation by layering:—The stems and the branches from one-year-old vines are made into *guchhi* (coiled vines). These are buried ½″ to 1″ deep in the fine sand in pots or near the parent plant in the soil. Their connections should not be severed before they send out roots from their nodes in the soil. Before making *guchhi* of the vine, their leaves are cut off. After burying in the soil, in the soil, in 10 to 15 days roots emerge from the nodes. Then they are taken out of the soil for propagation and their connections are broken from their parent plants. Now they are planted in the already prepared *thala* (pits) leaving the two ends of the *guchhi* with a few leaves out of the soil. Attention should be paid to irrigation till the vines spread all around and establish their root systems properly.

My personal observations and experience have shown that if for planting *parwal guchhi* are made in the month of August and September in fine sand and they are planted in February or March in the well prepared pits, the vines are very vigorous, spread very quickly after winter, and start fruiting. And the fruits are of better size and quality.

13. Irrigation is provided to the newly planted vines from the nearly rivers or by digging deep pits in the soil to secure sub-soil water. Hoeing should be done after each irrigation. Three or four irrigations are sufficient to allow the plants to develop their deep root system, after which no irrigation is required.

14. **Care of the crop:**—It has also been found by experience that if vines are given support so they can spread above the ground on thatches or sticks, they are less vigorous and give fewer fruits, and the fruits are attacked by the fruit-fly (*Dacus sp.*). But if they are spread over the ground, the vines are more vigorous and bear more fruits, and

the fruits placed on the soil covered with the vines escape damage by the fruit-fly. The vines spreading over the ground strike roots in the soil from their nodes and thus become vigorous by absorbing more water and food materials from the soil.

15. **Pests and other enemies of the crop:**—(i) The fruit-fly (*Dacus sp.*) is the most serious pest of the crop. It punctures the soft fruits, places its eggs in them and the larvae cause rotting of the fruits. Attacked fruits should be picked and destroyed to kill the larvae.

(ii) The pumpkin beetle is harmful to the new developing shoots.

(iii) Rabbits and porcupines (*saihi*) spoil and eat up the fruits. To scare them away scarecrows are prepared in the fields.

(iv) The other enemies of the crop are severe cold and excessive moisture.

16. **Harvesting and marketting:**—Fully grown green fruits are picked from the vines and they are sent to the neighbouring markets by the cultivators themselves, or the whole plots are sold to vegetable dealers who send the fruits either to the nearby cities or to distant places like Delhi and Meerut in the western districts where it is not cultivated. It is sold at up to two rupees a seer in those places. In the local market it starts selling from 12 to 14 annas per seer in March and April but as the rainy season approaches its price gradually comes down to 3 annas a seer. In the rainy season also when the crop of the locality suffers from flood water the price rises to 8 or 10 annas per seer.

Parwal vines give fruit from April to November and thus supply vegetable for eight months in the year. In winter, due to severe cold, the plants shed their leaves, store up their energy and food materials in their roots and do not produce fruits. The roots become tuberous.

17. **Yield and profit:**—The cultivation of *parwal* is being done by the illiterate growers, the yield and profit data is not available so far. If the plants are placed 8 feet apart, there will be about 700 in an acre. Taking two chhatak of fruits as an average yield per plant per alternate day, the total fruit yield per acre would be 10500 seers per annum. And if the average price of the fruits is taken as 6 annas a seer, the crop will be sold for more than Rs. 3900.

The total annual expenditure for one acre may be calculated as follows:—

		Rs.
1.	Establishment ...	50
2.	Preparation of pits ...	14
3.	Filling the pits with manure and soil ...	7
4.	Price of cow-dung manure (35 mds. plus cartage) ...	20
5.	Irrigation followed by interculture ...	28
6.	Planting the vines ...	7
7.	Price of the plants (*guchhi*) ...	14

		Rs.
8.	Irrigations (2 only) ...	14
9.	Care of the crop ...	21
10.	Harvesting ...	160
11.	Marketing ...	160
12.	Misc. expenses ...	80
	Total ...	575
		Rs.
	Net profit per year ...	3325

A net profit of about Rs. 3325 per year is obtained by growing one acre of *parwal*. The above profit is when the crop is sown mixed with *rabi* crops like wheat or barley. As it is a very profitable cash crop, cultivators should pay full attention to its cultivation in Bihar and also in other places where it is grown. Two or three vines if planted by the average family in their kitchen garden are sufficient to provide vegetables for many years. Each year they should be given 2 to 3 seers of cow dung manure in order to obtain more and better type of fruits.

In addition to providing one of the best kinds of vegetable, the *parwal* plants are thought to have medicinal properties. All the parts of the plants are used in indigenous medicinal preparations by the vaidas (physicians) (7). The tuberous roots of the vines may also be used as a substitute for tapioca. The tender tops of the vines are also used as pot herbs and are regarded as a tonic and febrifuge (1).

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One of nature's most interesting and significant phenomena is the ability of growing plants to absorb carbon dioxide from the atmosphere, which contains only a small fraction of one percent of this gas, and to elaborate it into tissue containing some 40 to 45 percent carbon.

COMPARATIVE STUDY OF IMPROVED VARIETIES OF WHEAT VERSUS 'LOCAL' AT DIFFERENT SEED RATES AND SOWING DATES IN AGRA.

By

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Introduction:—It is well known that compared to other countries our yield per acre of wheat is indeed very low. On an all-India basis it is only about 660 lbs. while in the U. P. it is about 780 lbs. as compared to 1713 lbs. in Japan and 1918 lbs. in Egypt. There is thus evidently ample scope for raising our wheat yields and thus more nearly overcoming our more-or-less chronic food shortage. Among the different factors known to contribute towards increased yields, the variety, the time of sowing and the seed rate are quite important. In the present note the results of a study of the performance of different varieties of wheat at different sowing dates and at different seed rates under Agra conditions are discussed.

Experimental technique:—A field trial was conducted by the author during the year 1949-50 at the B. R. College Farm at Bichpuri, Agra, to study the response of three varieties of wheat (Pb. 591, C. 13, and 'Local') to three sowing dates (15th and 30th October and 14th November) and three seed rates (30, 40, and 50 seers per acre i. e. approximately 60, 80 and 100 lbs. respectively) under irrigated conditions. The selection of sowing dates and seed rates was based on those recommended for U. P. generally i. e. the end of October and 80 lbs. respectively.

The design of the experiment was the 'single split plot' with sowing dates as main treatments and there were three replications. Although this design reduced the precision of information on sowing dates yet it was selected to avoid agricultural operational difficulties specially when quite an amount of information was available about the sowing time of wheat.

Various growth and developmental characters having a bearing on the yield were studied at successive stages of the life cycle of the crop but in the present paper only the yield performance of the three varieties of wheat at different seed rates and sowing dates under conditions prevailing in Agra, are reported for what they may be worth.

Experimental Results:—

(1) **Grain yield**:—Analysed statistically varieties and the interaction between varieties and seed rates were found to be significant at 1% and 5% respectively.

TABLE I.

Grain yield in maunds per acre.

Varieties	Yield	%age increase over local	C. D.
Pb. 591	25·83	38·87	5%—2·390
C. 13	20·66	11·07	1%—3·219
Local	18·60		

It will be seen from the above table that Pb. 591 has given the highest yield which is also statistically superior to both C. 13 and 'Local' at the 1% level of significance. The next best yielder was C. 13 but this was not statistically superior even at 5% level of significance. From the varietal point of view therefore Pb. 591 is clearly revealed the best of these varieties for Agra conditions.

TABLE II

Inter-action of varieties and seed rates on the grain yield (mds. per acre.)

Varieties	Seed rates 30 seers	40 seers	50 seers	C. D.
Pb. 591	25·04	26·40	26·04	5%—4·140
C. 13	21·18	18·96	21·82	1%—5·577
Local	22·58	16·46	16·74	

In case of Pb. 591 and C. 13, increasing the seed rate from 30 srs, to 40 srs. and to 50 srs. did not show any significant effect. In 'Local' however, the yield at the 30 sr. seed rate was significantly better (at 1%) than that at the 40 and 50 sr. seed rates, while the yields from the 40 and 50 sr. seed rates were practically the same.

At the 30 sr. seed rate, although Pb. 591 gave on appreciably higher yield than both C. 13 and 'Local', the differences were not statistically significant. The higher seed rates, Pb. 591 gave a significantly higher yield than the other varieties. The yield of C. 13 and 'Local' did not differ significantly at the 30 and 40 sr. seed rates but at the 50 sr. seed rate, C. 13 produced a significantly (at 5%) better yield than 'Local'.

It is clear that Pb. 591 is superior to both C. 13 and 'Local' at any of the three seed rates.

(2) **Bhusa (Straw) yield:**—Varieties and inter-action between sowing dates and varieties were found to be statistically significant at 1% and 5% respectively.

TABLE III

Bhusa yield in maunds per acre.

Varieties	Bhusa yield	C. D.
Pb. 591	75·43	1%—4·912
C. 13	67·76	
Local	73·95	

Pb. 591 and 'Local' were of equal merit as regards the production of *Bhusa* per acre and both were significantly (at 1%) superior in this respect to C. 13. It is to be noted that in *Bhusa* yield Pb. 591 is again at the top.

TABLE IV

Inter-action between sowing dates and varieties on *Bhusa* yield (Mds. per acre)

Sowing dates	Varieties Pb. 591	C. 13	Local	C. D.
15th Oct.	78·19	75·25	87·16	5%— 7·54
30th Oct.	77·47	65·10	69·80	1%—10·16
14th Nov.	70·60	65·20	64·90	

'Local' when sown on 15th October produced significantly (at 1%) more *Bhusa* per acre than either Pb. 591 or C. 13, whereas Pb. 591, when sown on 30th October produced *Bhusa* significantly higher than C. 13 (at 1%) and 'Local' (at 5%).

Pb. 591 sown on 15th October gave a significantly (at 5%) better yield of *Bhusa* than that sown on the 14th November while Pb. 591 sown on 30th October was very nearly significantly superior to that sown on 14th November.

C. 13 and 'Local' sown on 15th Octobet produced significantly (at 5%) more *Bhusa* than when sown on 30th October and 14th November.

It is clear from the above that Pb. 591 produced a higher amount of *Bhusa* per acre than C. 13 and 'Local' under all sowing dates except that 'Local' sown on October 15 outyielded it. There is also a tendency in every variety to give lowered *Bhusa* yields with delay in sowing.

TABLE V

Treatment-wise yields (in mds. per acre) for both grain and straw.

Treatments	Grain 15th. October	30th. October	14th. Nov.	Straw 15th. October	30th. October	14th. Nov.
Pb. 591 at 30 srs.	26·7	25·0	23·3	83·0	93·6	75·0
at 40 ,,	28·6	24·0	26·3	74·4	75·4	67·2
at 50 ,,	25·0	26·0	27·0	77·8	77·2	70·8
C. 13 at 30 srs.	19·0	22·4	22·0	70·8	79·8	73·8
at 40 ,,	17·4	18·2	21·2	81·2	59·8	68·2
at 50 ,,	21·4	19·8	24·2	73·6	67·6	66·5
'Local' at 30 srs.	20·4	24·6	22·4	81·6	67·6	61·0
at 40 ,,	14·6	11·8	22·8	97·2	62·3	69·2
at 50 ,,	12·8	16·9	20·6	86·2	71·8	65·4

The following points emerge from the above table:—

(i) Pb. 591 gave the maximum grain yield at the 40 sr. seed rate and 15th October sowing while the maximum *Bhusa* yield was given at 30 sr. seed rate and 30th October sowing.

(ii) At the 50 sr. seed rate, Pb. 591 gave lower grain yields with every delay in sowing from 15th October to 14th November. This tendency for lowered yields in delayed sowings is reversed at the 50 sr. seed rate where the yields increased with every delay in sowing beyond 15th October. It would thus appear that when sowings are delayed the seed rate in Pb. 591 can be profitably increased for better yields.

(iii) The best seed rates for C. 13 are 30 srs. when sown on 30th October and 50 srs. when sown on 14th November.

(iv) 'Local' gives the best yield with the 30 sr. seed rate at all the sowing dates generally. It is, however, indicated that a higher seed rate of 40 srs. may be advisable in sowing on 14th November.

Main Conclusions.

The results reported in the present paper are based on one year's trial. Hence they cannot be taken as absolutely dependable. But certain well-marked tendencies, such as Pb. 591 being the best variety of the three, as regards both grain and *Bhusa* yields and that an increased seed rate gives better results in delayed sowings, can be depended upon for Agra conditions.

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INSECTS IN RELATION TO OUR LIFE

By

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This is a subject of general interest and those who know little about insects will find it all the more interesting. Readers will add some information to their knowledge about the role of insects in our daily life.

Insects comprise about 70% of the known species of all kinds of animals. Before I may say anything else, it seems to me necessary to say a few words about their evolution.

There are two schools of thought. One school believes in the Trilobite theory and is of the opinion that the earliest insects were winged forms represented by the extinct palaeodictyoptera which were derived from trilobites. In this case the wings had developed from the pleural expansions. Such traces have been studied in these fossil insects. But this has not been generally accepted as there seems to be a wide gap between trilobites and insects. The second school accepts the Crustacean theory which maintains that the primitive type of insect was wingless and is represented with the least modification by the Mechilidae. The theory is based largely upon identity, similarity, and homologies of certain appendages of *Machilis*. This descent it is claimed took place by the crustacean forerunners migrating to the land and thus evolving into primitive wingless insects. These relationships between insects and Crustaceans, however, are remote and the balance of evidence suggests their origin rather than the actual derivation of insects from such ancestors. From the study of palaeontology we see that the insect fossils from the Devonian, Carboniferous, Permian, and Jurassic periods have been kept in the records. The strata where the richest and most important recent discoveries in fossil insects have been made are of the Permian and Triassic ages. Altogether about 11,500 species of fossil insects are known, and of these approximately 1/5th belong to orders or families no longer existing today. It is remarked that various forms of insects have disappeared from the world without man having ever been even aware of their existence. In India insect fossils from Tertiary times and also from the Miocene age have been recorded from the inter-trappean beds of Nagpur, Bombay, and especially parts of Madhya Pradesh, Northern Hyderabad, Berar, and north of the Narbada Valley. Mention has also been made of some of the existing insects like the honey bee, locust and even the termites in the Vedas, Quran, and the Bible.

As civilization advanced, more crops were brought under cultivation, the number of insect pests also increased simultaneously and today we find that the insect pest population has increased enormously. It is interesting to know at what rate the insects are multiplying both in space and time and how high the mortality is on the other hand. Huxley and Buckston (1896) estimated that the progeny of a single female aphid reproduced parthenogenitically (reproduction without fertilization) if all the members survived would be 15 to the power of 210 (15^{210}). With regard to the sexual reproduction where the fertilization is complete, Parkins (1924) in the

case of the Hawaiian cane leaf-hopper *Perkinsiella Saccharicida* which may lay 50 eggs (and the sexes are about equal) calculated that if there were six generations in a year the undisturbed progeny of one female would amount at the end of twelve months to about 500,000,000. Similarly in the case of the spotted boll worm of cotton *Earis fabia* which lays about 235 eggs and also completes twelve generations at the optimum temperature of 35°C, the single progeny would be 20 trillion individuals. Further if 100 insects weigh 1 oz. then the weight of this progeny would be 600 billion tons and if 1000 measure one cubic inch in volume then they would cover 51 million square miles to the depth of 81 feet. This hypothetical biotic potentiality is not at all true. There is an equal balance of production and destruction in nature; otherwise it would have been impossible for us to live.

The insects are both our friends and foes. The damage caused by these insects is far greater than the benefit to our econmic life. The damage that some of these cause to field crops, orchards, stored products, and household materials and the part that some of these have recently been found to play in interfering with man's health and convenience, as household pests, are matters of no small importance. Nor can we overlook the other side of the picture, viz., the value of some insects to man in various ways as suppliers of useful products like silk, honey, lac, etc., and as man's friends in checking injurious insects in the form of scavengers, parasites, and predators.

Apart from these points mentioned above, insects have also been used as a source of income directly or indirectly. In most parts of the United States of America, particularly in California, bee-keepers are paid for keeping their hives in orchards by the owners of the orchards. These insects feed on the nectar of the flowers and bring about pollination. Many other crops are benefitted in the same way.

Insects have also been used as food as in the case of locusts and termites in some parts of India, China, Iran, Arabia and Nepal. Some insects like termites and bed bugs are said to be used for medicinal purposes.

We have yet to learn one important lesson from these insects. The social insects like bees and termites teach us the method of the division of labour. Their social organization is older than that of man and many thinkers have compared the civilization of the bee with the civilization of man, always to the honour of the bee and to the detriment of man. The Prophet Mohammed has in the Quran recommended to his followers the study of bee life as an object lesson for mankind. They are thus considered as social beings and are undoubtedly far superior to man. Their social organization has something of the perfection of a machine. In a word, the society of bees is a theoretically perfect communist state of the extremest type. We humans are mere infants in the era of living in society, while the bees and ants are now old at this sort of living, so old that the individuals have lost the capacity of being able to live apart from their society. The function of the queen is only to lay eggs. After mating it is looked after with extreme care and devotion. The drones are the male bees and their only function is to fertilize the queen while the undeveloped females, known as workers, form the bulk of the colony of from 15, 000 to 40,000 "Her majesty the queen holds court and the wedding flight of the queen is the funeral of the drone." A similar type of division of labour is

also noticed among the termites where queen, king, workers and soldiers have to discharge the duties of their individual responsibilties.

Last but not least, mention of the disease-carrying insects is to be made. Under this category come the insects which not only affect the person of the house-holder and cause trouble and annoyance but also contribute to the transmission of some well-known diseases of plants, animals and men. The housefly (*MLsca-domestica*) is held responsible for the spread of typoid, cholera, diarrhoea, dysentery, and tuberculosis. The eye-fly (*Siphonella funicola*) spreads some common complaints of the eye. Mosquitoes, both *Culex* and *Anopheles* are guilty of the spread of diseases. That malaria germs are spread by *Anopheles* is well known, and species of *Culex* have been found to be the transmitters of diseases like filariasis (elephantiasis which is common in Bihar) and dengue fever. Fleas (human, rat, dog and cat) carry various diseases, and the rat flea (*Xenopsylla cheopsis*) transmits bubonic plague. Lice (head, body and crab) carry relapsing-fever, typhus and trenchfever and the bed-bug (*Cimex rotundatus*) is suspected to spread the serious disease known as *kala azar*. The Tse tse fly (*Glossina palpalis*) causes both in man and animal the disease very common in Africa knows as sleeping sic kness. Virus in plants is spread by aphids and other insects. Thus both agricultural and medical quarantine measures are to be adopted in each country to check the spread of the foreign economic insect pests and disease carrying insects.

The knowledge of insects and their general habits and the study of their life cycles, therefore, will not only help man to devise ways and means to fight the pests of agriculture, forests, and good health but will also help him to take advantage of the products of useful forms and to benefit by the helpful activities of friendly insects.

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It is said that maize is capable under favourable conditions of producing more pounds of grain per acre than any other cultivated crop.

GUAVA CULTIVATION*

The guava is one of the important fruits of India. It is very popular because it is comparatively cheap, and has a flavour which many like. It is mainly consumed as a fresh fruit, being sweet and palatable and considered good for health. It is very rich in Vitamin C. It also is an excellent source of jelly, "cheese" and jam, and it can be preserved by canning in sugar or *gur* syrup.

Climatic Requirements:

It can grow in a wide range of climate. While it may not survive heavy frosts, which may kill the trees it does survive mild or moderate frosts and can be successfully grown up to an elevation of 3,000 feet. It stands drought fairly well and survives the hot dry seasons in the U. P. It has no special soil preference and can be grown on a wide variety of soils from heavy clay to light sandy soil, and does fairly well even on comparatively poor soils. It does not require a great deal of care. Young trees grow well and mature rather quickly. Next after the papaya and bananas it gives the quickest return after planting. It is an orchard tree suitable for the rich and poor alike. Uttar Pradesh is the main area of guava cultivation in India.

Near Allahabad many people make a profit from planting guava orchards and marketing the fruit. Others make a profit from making guava jelly and guava cheese, or canning the fruit. There is still opportunity for others also to share in such profits by rising guavas.

While it is a fruit suitable for small homes and gardens for private us it is also commercially grown in orchards. It starts fairly easily and begins fruiting as soon as the flowers are allowed to remain. By the fourth or fifth year there is likely to be enough fruit to pay for protecting it, and with proper care may give a profitable income for 20–25 years, or even longer if well cared for and all its requirements are supplied. Guavas are unusual in that two crops of fruits are obtained each year. The minor crop comes in the monsoon season while the main winter crop is harvested from November to January.

Varieties:

There are many varieties found in U. P., the most important of which are:

1. Safeda—The fruits are round, with a smooth skin, white or light yellow and quite sweet. The flesh is light coloured it is very popular.

2. Chittidar—The fruit is similar to that of the Safeda, but has red spots on the light coloured skin. It is next to the Safeda in popularity.

*Adopted from a pamphlet in Hindi written by Mr. Theodore Dean of the Horticulture Department, Allahabad Agricultural Institute and published by the Extension Project, Allahabad Agricultural Institute.

3. Apple guava or red skinned variety—This is similar to the Safeda except that the skin may be pink or red all over, like an apple. The flesh is usually light coloured but less sweet.

4. Hafsi—The skin of these fruits may remain green even when ripe, or may be light yellow. The flesh is red and somewhat less sweet than the other varieties.

Propagation:

Guava trees may be obtained either from seed or by grafting.

(a) Seedlings can be very easily raised by planting the seeds of selected plants during the monsoon season. This is very easy and cheap but the trees from such seedlings may exhibit a great range of varieties and the fruits may vary widely from that of the mother plant. Many seedling plants may give poor trees with inferior quality fruit which yields little income.

(b) Grafts. These trees are somewhat expensive as they usually have to be purchased from a reliable nursery. These trees develop into the same type of tree and give the same kind of fruit as the mother plant from which the graft was taken, and are therefore more reliable with less risk of unprotfitable trees.

Planting System:

When laying out a guava orchard one must avoid the common errors. The mistake most frequently made is that of planting the trees too close together. Thus when the trees reach maturity after several years they are crowded and shade one another and leave no room for further development. The crop of fruit is reduced and the income from each tree less than it should be. Even though there are more trees per acre, still the entire yield is less than can be had from fewer trees, each of which has sufficient room for full growth. Grafted guava trees should be planted 20 to 25 feet apart in each direction, and when on good soil, seedlings should be give even more space. When the trees are first set out and are very small this may seem excessive. But all of this space is needed by the full grown mature tree, so do not make the mistake of too close planting.

Either the square or the hexagonal system can be used for planting a guava orchard. About 48 to 108 trees can be planted per acre. For further details consult the Extension Project Bulletin, "Planning and Laying-Out of Orchards." (See page 112 this issue.)

Pruning:

Often very little attention is given to this point, but it is important and some pruning is necessary. Pruning is necessary firstly to shape the frame-work of young trees, and secondly to keep the grown-up trees clean and healthy.

(a) *Pruning of young trees*: It is at this stage that many trees are ruined for want of proper care in pruning. The tree should be pruned to 4 or 5 well balanced branches radiating from she main stem. These will grow into the main frame of the tree.

(b) *Pruning old trees*: Pruning in older trees is generally restricted to the cutting of broken or dry branches and the removal of water sprouts. If two branches start to rub against each other, one may be removed. Especially in the early years of bearing, branches should he shortened to lessen the danger of breakage.

Manuring of guavas:

Like other trees, guavas also should be manured. If possible some manure should be applied annually. The manure should be applied around the tree and ploughed under. This is usually best done during or after the rains.

Irrigation:

In many places guavas are grown without irrigation, but on the plains of Northern India the fruit produced under such conditions are not large and the yield is generally low. For good quality fruit and high yields some irrigation is needed. At least two irrigations should be given between the end of the monsoon (early October, and December). This is necessary to mature the main crop of fruit which is given from November to January, and the cost of such irrigation is well repaid by the quality and size of the fruit.

If one wishes to take the minor monsoon crop, then irrigation is necessary in the dry season before the onset of the monsoon, that is, February to June. Irrigation at this time will encourage blossoming and setting of the fruit for the monsoon crop. But the monsoon crop is never so heavy, and the fruit is of poor quality and yield. It is not really important. A heavy set of monsoon fruit may decrease the yield of the winter crop, so most guava growers do not encourage a heavy monsoon crop, preferring to concentrate on the main winter crop. Some irrigation, however, may be given in the dry season to keep the trees in good conditon untill the monsoon arrives, even though a large monsoon crop is not desired.

Cultivation:

The orchard should be cultivated as needed to keep it free from weeds. Weeds take away nutrients and moisture needed by the orchard.

Livestock food has become the major use of molasses in U. S. A. The manufacture of alcohol has consumed a large proportion of the supply of industrial molasses in years past. But development of a synthetic alcohol process based on petroleum products and increasing appreciation of the nutritional value of molasses for animal feeds have shifted the use pattern. The current trend indicates a further upward swing for feed use. The gains by synthetic alcohol, and the high price molasses brings for feed, combine to suggest that alcohol fermentation will continue to lose its position in the picture. The high price of corn has been a factor too. The latter, reflects the increased attention farmers are giving to economics in their practice.

PLANNING AND LAYING OUT OF AN ORCHARD*

There has been a considerable increase in the amount of fruit being raised in India and more orchards are being planted now than ever before. Raising of fruit is one of the best ways to improve the health of the people and the economics of the country.

Planning an orchard requires careful thought and there are a number of points which should be kept in mind.

(1) Selection of site.

This requires consideration of several things:

(a) The soil: Any soil on which wild trees or agricultural crops grow well is suitable for fruit trees. However, as trees are deeper rooted than most crops, care should be taken to see that the soil is deep enough and not under-layed with rock or gravel or *kankar* beds too near the surface.

(b) Water: Without irrigation young trees cannot grow properly nor do old trees bear well. Arrangements for irrigation should be made before planting the orchard.

(c) Commercial orchards should always be sufficiently near to a good market and have satisfactory transport facilities available. Fruit is bulky and requires careful handling if it is to arrive at the market in good condition. Even when it is transported only a short distance, care should be taken to avoid bruising the fruit.

(2) Preparation of site.

After the site has been selected its preparation should be considered. It may require levelling. The level of the field should be such that the high point is near the source of water and that water can reach every part of the field by gravity flow. Smoothing of the land to the proper levels and slopes should be done before the planting of trees, Frequently it is desirable that the main irrigation channel be made *pucca.*

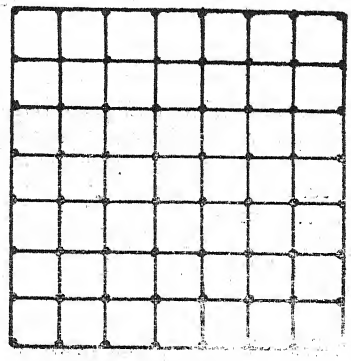
Before planting the trees, the soil should be prepared by deep ploughing. If this is done during the summer months the weeds and grass will be killed, and the field may be made ready for planting during the monsoon. The fields should also be well manured with farmyard manure or compost if available. This may be done several months before planting. If such manure is not available the soil can be greatly improved by growing a crop of green manure like sunn hemp, *gowara* or *dhaincha.*

(3) Lay-out of the orchard.

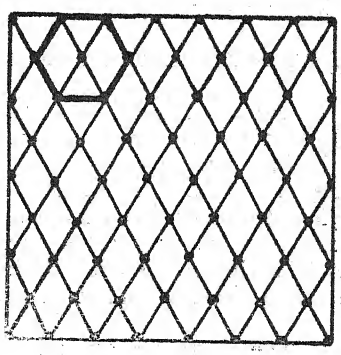
In most cases it is better to lay-out the orchard so that the trees are planted in straight lines in a definite geometrical pattern. This allows

*Adapted from a Pamphlet in Hindi written by Mr. Theodore Dean of the Horticulture Department, Allahabad Agricultural Institute and published by the Extension Project, Allahabad Agricultural Institute.

better supervision, allows interculture by ploughing and facilitates the placing of the irrigation channels. It also improves the beauty of the orchard and gives each tree the required space in which to grow and develop. Several simple systems of lay-out are given below: (see illustration)



SQUARE



HEXAGONAL
(or Equilateral Triangle)

In the above plan there are 64 trees in the square pattern and 68 in the Hexagonal, in an area of land slightly less than that occupied by the square. The advantage of the hexagonal pattern increases with the total area of the plot available. In small plots the advantage may be only one or two more trees. In large orchards of sizable area the advantage is increased upto 15% more trees from a given area and without crowding as there is the same distance between trees in every direction.

(a) The square: In the square system the distance between rows and the distance from the plant to plant in the same row is equal. This distance will depend upon the nature of the plant and its particular requirements.

(b) The Rectangle: Sometimes some people prefer to increase slightly the distance between rows and to decrease slightly the distance between the trees within the row. This results in a rectangle in which the trees have full distance in one direction but may be slightly crowded in the other direction. This may result in a few more trees or in more room for operations between the rows, but the crowding in one direction may lead to a reduced yield per tree which partly offsets any increase in yield due to the increase in the number of trees.

(c) The Hexagonal system: By this system six trees are planted at the six corners of a hexagon with one tree in the centre. Three trees form an equilateral triangle. This allows about 15% more trees per acre than the square system with the same minimum distance between trees. This is a distinct advantage, particularly in large orchards, and large commercial orchards often follow this system. In small orchards the advantage may be less marked. The illustration shows the pattern for laying out the square and hexagonal systems.

(d) Irregular patterns: When the orchard fields are small or with irregular boundaries it is often impossible to follow exactly any system of geometric pattern. This also applies in hilly areas where orchards are planted on terraces of irregular shapes. In these cases one has to plan his orchard as best he can without necessarily following any pattern but

taking care to see that trees are not crowded while at the same time allowing for as many as possible in the given area. In terraced fields, with fairly high walls on the downhill side, trees can be planted somewhat near the edge so that when mature the branches may overhang the terrace to some extent and may even slightly overlap trees below on a lower terrace.

(4) **The distance between trees:**

The most satisfactory and easiest way to determine the space required by a particular tree is to measure the spread of a fully grown tree of a similar variety growing in that locality, without crowding by other trees. The most common mistakes made by orchardists is over-crowding and trying to plant too many trees within a given area. When planted too close the branches of adjacent trees spread and grow into each other resulting in interference with cultural operations, in shading, and in reducing the yield of both trees.

The distances required by different fruit trees as given below may serve as a guide but should not be taken as a hard and fast rule, since the growth of trees depend upon climate, soil, cultivation, variety, and other factors of a local nature:

Mango (grafted)—40 ft.
Mango (seedling)—60 ft.
Guava (grafted)—25 ft.
Pomegranate—15-20 ft.
Jackfruit—40 ft.
Banana—6-10 ft.
Papaya—8-10 ft.
Orange—20-25 ft.
Kaghzi lime—25-30 ft.
Other citrus fruits—about 25 ft.
Jamun—30-40 ft.
Ber (Pruned)—25-40 ft.

These distances may seem excessive when first laying out the orchard with very small plants but the full distance is required when the trees become mature. It is sometimes feasible to make temporary use of the intervening space while the trees are growing by planting quick growing fruits like the papaya which will give several crops and be finished before the slower growing larger trees attain much size. Or the space may be used for vegetable or other annual crops.

(5) **Planting the orchard:**

When planting the orchard different kinds of trees should not be mixed together. Each kind of tree should be planted in a separate block of its own at the distances required for the particular type of tree. Trees mature at different periods and fruit at different seasons so that a mixed orchard is a handicap. It makes for easier watching and harvesting if all the trees of the same kind are in one place.

(6) **Where to secure the young plants:**

The plants should always be purchased from some reliable nursery. Plants or seeds from such places are likely to be more expensive than those secured from unreliable places. This expense is well repaid when the orchard matures. The unreliable nursery may supply any kind or variety of tree it can sell and will label it whatever the purchaser is asking for. He may then plant his orchard with unreliable trees only to find, after waiting for some years, that the trees are of little value, with low yields or

of unsuitable variety or quality so that they fetch lower prices on the market. He is then put to great loss and would have no resource against the nursery after such a long time. However, the asking of high prices is no proof that a nursery is reliable.

(7) **Age of the plants:**

Never plant trees which are 3, 4, or 5 years old. If the tree is healthy it will be too large for transplanting successfully at that age. If a tree is small enough for transplanting when it is that age it is probably not very healthy and would therefore not be desirable. It is best to purchase plants which are one or two years old when transplanted.

(8) **Setting out the trees:**

The trees are generally planted in holes which are dug at the proper location where a stake has been set to indicate the point at which each tree is to be planted. These holes should be large enough to take the entire root system of the plant. Avoid making the hole too small so that the root are bent or cramped when planted. On the other hand avoid making a very big hole as this has its drawbacks. A very large hole has no particular advantage if it is larger than necessary and it is expensive. A large hole may encourage planting the tree too deep so that it rests in a depression or the part of the stem which should be above the ground remains below the ground when levelled. This may harm the tree or may lead to damage by termites. The trees should be planted at the same depth at which they were growing in the nursery. They should be set out slightly higher so that when the soil settle in the hole, the trees will be not lower than ground level. Trees should be irrigated very soon after transplanting. Consideration should be given to the proper time of planting. Generally speaking it is best to set out the new orchard during the monsoon or in the early spring when it is comparatively cool. Decidious trees are best planted in the late winter. Young trees may require shading during the forthcoming hot season. This may be done when the sun begins to get hot by building a small mud wall around the tree and covering it with bamboo slats or a grass thatch which will give partial shade but allow some sunlight to penetrate. When the monsoon arrives the thatch should be removed and the mud wall levelled. Young trees may require this type of shading for two or more seasons until they have become very well established and can withstand the hot sun and dry winds of summer.

There is no present theory which explains satisfactorily the phenomenon of selective absorption of ions by plants. As an example of this, many plants contain more potassium than calcium, yet the soils in which they grow contain a significant predominance of calcium over potassium, both in the soil solution and on the exchange complex. Even more dramatic is the ability of certain sea plants to accumulate large quantities of potassium and virtually no sodium. Yet the water in which they grow contains many times more sodium than potassium and the two ions are chemically very similar.

LINE SOWING OF ARHAR AND JUAR*

Early in his training the agriculturalist learns about the four requirements for growing a crop: soil, water, sunlight and air. Plants in the field do not compete with each other for air, but they do compete for plant food, water and sunlight.

The grower can help each plant get sufficient food, water and sunlight by sowing his seed at an even depth. This helps ensure even sprouting and even emergence of plants. A plant that comes up one week later than the surrounding plants may be shaded and thus it will be stunted, or most of a certain plant food, such as nitrogen, may be taken by the other plants before it can get its share.

Seeds should also be sown with even spacing to give each plant enough soil in which to spread its roots and from which to draw food and water. If plants are too close together they become stunted and their yield is reduced.

Another way by which crops may be deprived of plant food and water in the soil is by weeds. Many tough, woody weeds take as much plant food from the soil as a larger, more edible juar plant. Weeds shade crops. In India we tend to be unaware of the damage done by even a very few weeds. In one instance, yields of maize fodder was more than doubled by careful weeding after the field had been declared "well weeded".

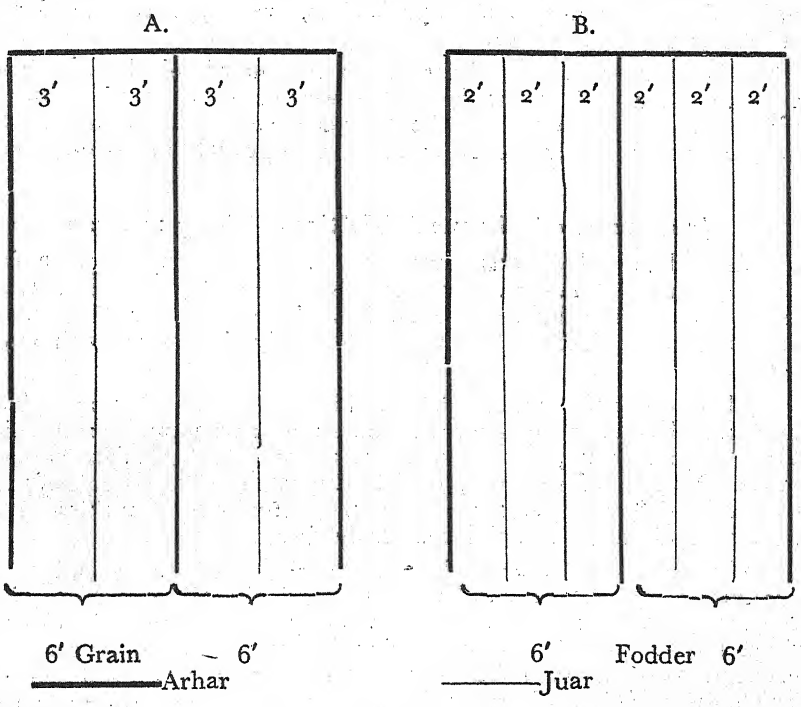
Line sowing (that is, sowing in straight lines or rows) does not in itself give crops more plant food or water, but it does help each plant to get its share of food and water.

When seed is broadcast and the field is then ploughed, some seed is buried so deeply it never comes up and some is left on top of the ground where birds and rodents can easily find it. The plants that do come up are often uneven in growth and blank spaces are left where the plough and the birds have done their damage. Line sowing gives an even depth of planting which means that plants compete more uniformly for food, water and sunlight, and it also saves seed because a larger percentage of the seed planted grows. When crops are sown in lines, weeds can be controlled effectively by bullock, or tractor drawn implements.

When juar or sorghom is grown as a single crop, rows should be two feet apart if it is to be harvested for fodder and 2½ to 3 feet apart if it is to be harvested for grain. Seeding rate should be 8 seers per acre for fodder and 5 seers per acre for grain. For grain the distance between seeds should be six inches and for fodder three to four inches. By this method and rate of seeding as much as 30 mds. of grain or 400 mds. of fodder per acre have been produced.

*Adapted from a Pamphlet in Hindi by Messrs. N. R. Dey, A. K. Ghosh and H. Joshi of the Agricultural Institute staff and published by the Extension Project, Allahabad Agricultural Institute.

Recent trials at the Agricultural Institute, Allahabad, indicate that juar can be very suceessfully grown in combination with arhar. or pigeon pea. One line of arhar is planted between every other or every two rows of juar as shown in the accompanying diagram:



"A" shows recommended spacing used when juar is to be harvested for grain and "B" shows spacing used when juar is to be cut for fodder. Juar is planted 5½ to 6 seers of seed per acre and 6 seers of arhar are planted when juar is to be cut for fodder. When juar is to be harvested for grain 2½ to 3 seers of juar and 6 seers of arhar are planted per acre. The distance between the lines of arhar should be 6 to 8 feet and between seeds in the row, two inches. The seeds of juar when this crop is being grown with arhar should be spaced three to four inches apart in the row.

Advantages of this combination are that the fibrous roots of juar feed nearer the surface of the soil and the tap roots of arhar feed more deeply. Arhar is a legume and juar is a non-legume. Because of the ability of legumes to take nitrogen from the air and convert it into available nitrate, arhar can continue to thrive even after the faster growing juar has taken most of the readily available nitrate from the soil. The juar is harvested when mature and the slower growing arhar is left to mature later, which requires several months longer.

Other crops may be grown to advantage in combination with arhar. Some of them are mung or green gram, (*Phaseolus aureus*), cowpea or lobia (*Vigna sinensis*), and ground nut (*Arachis hypogaea.*) For these combinations the lines of arhar are sown the same distance apart as that recommended when it is grown in the combination with

juar, but only one row of ground nuts or of the spreading varieities of cowpea are sown in between the lines of arhar. Two lines with 24 inches between lines of bush type cowpea, or three lines 18 inches apart of mung are sown between lines of arhar. Seed rate for arhar is the same in all of the above cases and for ground nuts 20 seer (without shells), for spreading type of cowpea 4 seers, bush type cowpea 6 seers, and mung 3 seers per acre.

After harvesting any of the crops mentioned which are planted in combination with arhar, the soil between rows of arhar should be cultivated. Cultivation should be only deep enough to kill weeds; and shallow enough so that as few arhar roots as possible are disturbed.

Just Trace of Chemical Multiplies Sheep to Acre

Australian soil experts have come up with a way to graze from two to 40 times as many sheep per acre as are presently grazed in certain areas with good rainfall in Australia. In some cases this can be done simply by adding up to an ounce of molybdenum to each acre of pasture.

This discovery means that millions of acres of now almost unutilized Australian territory will be open to agricultural exploitation. A. F. Gurnett-Smith, agricultural adviser to the Australian Scientific Liaison Office in Washington, explained that this is the result of study of the role of " trace elements " in the soil-minute quantities of, for instance, zinc, copper, sulphur and molybdenum.

The lack of certain of these trace elements causes land to be unproductive, as has been known to agriculturalists a long time. Australia, with her soils worn out in many places by geologic old age, offered ample grounds for pioneering in trace-elements research. In the U. S. by contrast, it has turned out that most of the soil does not require the addition of molybdenum or even other trace-elements, since it already contains the necessary amounts.

Some 340,000,000 acres of unimproved land, Dr. J. Griffiths Davies, associate chief of Australia's Division of Plant Industry, Melbourne estimates, can be converted, wherever the Australian climate permits into lush grazing ground.

Having found, after some 15 years of research, which elements and how much of each are needed for different soils, the Australians now know that in the Southern Tablelands of New South Wales, for instance, small amounts of phosphorus, sulphur, calcium and molybdenum will enable some millions of acres to feed three sheep per acre. This contrasts to the previous ratio of one sheep to two acres.

In the southeast of South Australia, the addition of superphosphate, copper and zinc, it is found, changes the ratio from one sheep to 20 acres to two sheep per acre.

Such remarkable changes are forecast for areas where the rainfall is adequate. In the great deserts of central Australia, extreme aridity continues to defy agricultural development.

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VOL. XXVII No. 2

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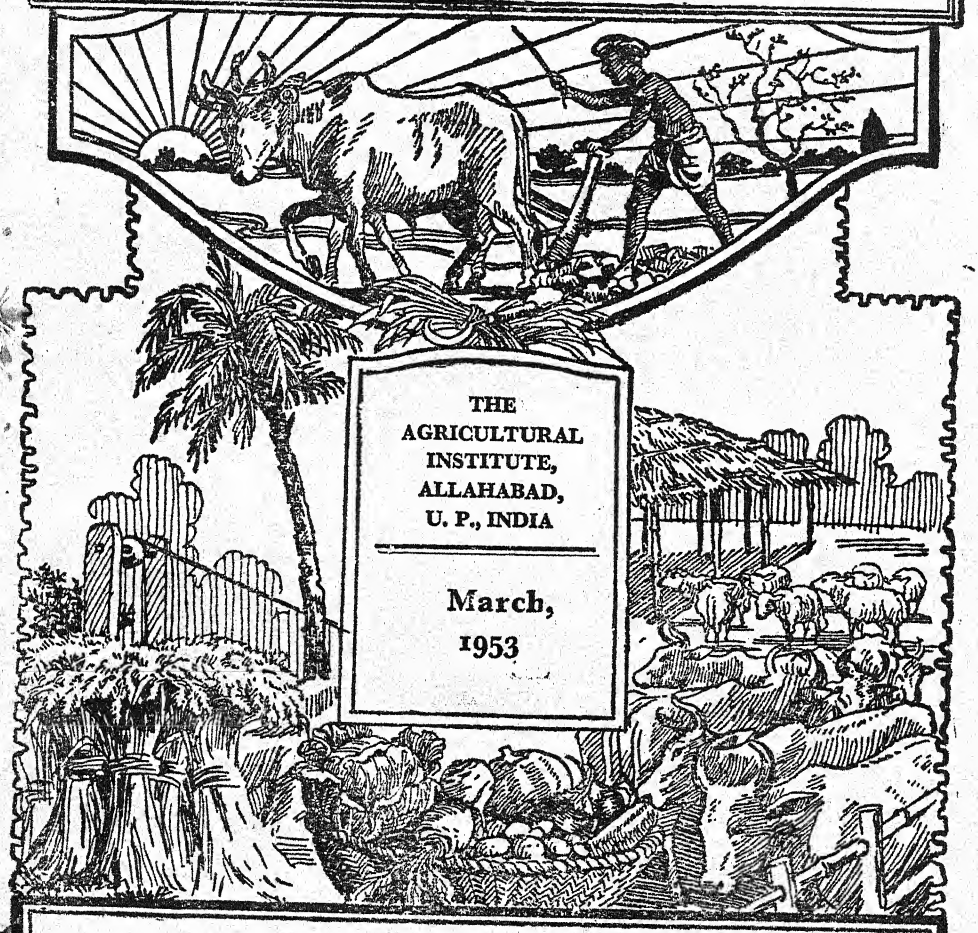

THE AGRICULTURAL INSTITUTE, ALLAHABAD, U. P., INDIA

March, 1953

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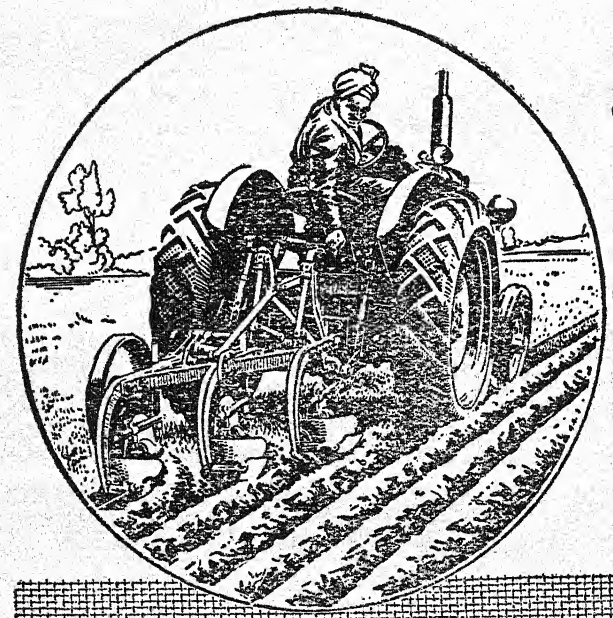
—*Du Pont Magazine.*



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The views expressed in the articles are not necessarily those of the editor.

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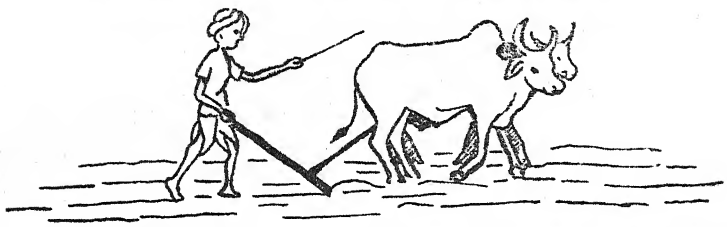
CONTENTS

EDITOR'S NOTE:

The Editor regrets the long delay in publication of this issue of the Allahabad Farmer due to reasons beyond his control but in no way the fault of the press. He regrets the inconvenience caused readers and subscribers.

The next two issues are ready for publication and should be out very soon. Subsequent issues for 1953 will follow before long and it is hoped to be back on schedule by the end of this year.—*Ed.*

THE
ALLAHABAD FARMER



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BAJRA (*PENNISETUM TYPHOIDEUM* RICH)

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Pennicillaria, cat-tail, pearl, Egyptian, bulrush millet and babala (S. Africa) are some of the names used for one of the common fodder and grain crops of India, *bajri*, and *cumbu*, *Pennisetum typhoideum* (*glaucum*).

Origin and History : It has been grown since prehistoric times, is reported to have been utilized by the Lake Dwellers of Switzerland, and as early as 2,700 B. C. it was grown by the Chinese. From China it was gradually introduced into India. From India it was taken to the West Indies and thence to U. S. A. in the year 1849. The crop is said to have originated in Africa and Arabia.

Habitat and Distribution in tropical and sub-tropical countries : It is grown in India, Africa, the Near East, China, the West Indies, and the U. S. A. to a certain extent. The total acreage in India in 1951-52 was 2,18,77,000 acres, and the production 21,56,000 tons, being chiefly grown in Bombay (40,00,000 acres) in the districts of Khaira, Anand, Borstad, Petlad, Nadiad, and Charotar ; Madras (35,00,000 acres) ; U. P. (22,50,000 acres) ; Hyderabad (20,00,000 acres) ; and Madhya Bharat (10,00,000 acres).

Climate : Bajra is a hot weather crop. When irrigated it can be grown as a *zaid* crop, but usually it is a *kharif* crop in northern and central India. It grows well in arid and semi-arid regions, having a rainfall of 15 to 35 inches annually. It is hardy and a drought-and high-temperature-resistant crop.

Soil : Bajra does well in sandy loam soils, and well drained light soils, e.g. red or grey sandy soils, even gravelly loam. On richer soils like the Black Cotton, the growth is luxuriant and mostly vegetative, suitable for fodder, silage and forage.

CULTIVATION OF THE FIELDS : For a *kharif* crop a somewhat thorough cultivation is required, which may be given by ploughing the field two or three times with an improved plough, followed by a harrowing with a spring tooth harrow, if required, and one planking with a planker, or *henga*. For an irrigated hot weather crop, or *zaid* crop, the fields are manured in winter, and the manure well ploughed with a *desi* plough five times, or harrowed in, or cultivated thrice with a soil-turning plough.

TIME, METHOD AND AMOUNT OF SEED FOR SOWING : For a *kharif* crop it is sown after the first few showers of heavy rain, about the end of June to mid-July. For a *zaid* crop the land is irrigated from the middle to the end of March, and the field is prepared as soon as it is dry enough to be ploughed, approximately by the first week of April. Usually it is broadcasted, or sown mixed with *arhar*, *til*, *urd*, *mung*, castor, or cotton when sown as a *kharif* crop, in rows three to six feet apart, with three or four rows of one crop and then three or four of the other. For fodder it should be dibbled, or preferably drilled in rows 15 to 24 inches apart, depending on whether the crop will be intercultured by hand or by bullock power. The spacing on heavier soils may be greater, ranging from 18 to 30 inches. On the light soils where tillering will not be so developed the crop can be grown for grain. For fodder, heavier soils or heavily manured ordinary soils give better results.

The seed rate for grain, as a single crop is 2.5 to 4.0 seers per acre, sown in lines or dibbled. In mixtures 1.0 to 1.5 seers of seeds may be required depending on the number of crops, and on the type of soil. For fodder the seed rate varies from 6 to 8 seers, depending on the method of sowing. Less seed is required for light soils or when the crop is drilled or sown in lines at a definite spacing.

Seeds are sown 0.5 inches deep ; if broadcasted they are covered by running a planker over the field. When seeds ar dibbled for fodder 4 to 6 seeds are used and later on some seedlings are removed, leaving 1 or 2 per hole.

MANURING AND IRRIGATION : For a *kharif* grain crop no manuring or irrigation is given ; the crop utilizes the rain water, and if grown as a mixed crop, is benefited by the legumes in the mixture. For a fodder crop 5 to 10 cart loads of compost or farmyard manure may be given, or the crop may be irrigated with sewage or sullage water, in which case such a high degree of manuring will not be required. Tank or urine earth may also be given instead of manure. For grain, 50 lbs. of superphosphate or 100 lbs. of well pulverised bone meal should be applied, either ploughed in, or top dressed a month after planting, if the soil lacks available phosphorus. A dosage of 2.0 cwt. of nitrolime, plus 56 lbs. of superphosphate per acre increases the yield by 44 to 73% [Krishna Rao and Nambiar (1952.)]

Bajra grows well in areas of moderate rain and sunshine. When bajra is grown as a *zaid* crop, once the field is prepared it may be divided into plots of convenient size by making irrigation channels with a *pharwa* or a double mould-board plough, or a furrower, to facilitate irrigation of the field. A second irrigation is given after 15 to 20 days, and subsequent ones at intervals of 10 to 14 days, depending on the conditions prevalent. Germination takes place 5 or 6 days after sowing.

INTERCULTURE : In a grain crop, sown in lines, or rows at definite spacing, interculture is done with a cultivator, hand hoe, or *khurpi*, after two weeks of growth, and subsequently whenever required. When the crop is grown for fodder it is intercultured after each irrigation till the plants grow to a height of about two feet. Practically no interculture or weeding is done in a mixed, or broadcasted *kharif* crop.

Proper interculture increases the tillering capacity of the crop, encouraging a large number of tillers, which vary from 20 to 30 or even more thus increasing the fodder yield.

HARVESTING AND YIELD : The crop for grain matures in 3 to 4 months time, e.g., in September-October. Maturity is influenced by the variety grown, purpose for which grown, and slightly by the ecological factors. Plants are cut by labourers with sickles, as close as possible to the ground.

The yield of grain from a pure crop of bajra is 4.5 to 6.0 md. per acre ; under very good conditions of growth the yield goes up to 8.5 or 10.0 md. per acre. For fodder purposes bajra is harvested when the crop heads, normally giving a yield of 130 to 150 md. or about 2300 to 2500 bundles of green fodder. For forage, the crop can be grazed or cut in the earlier stages, giving palatable green feed, and allowed to grow again. If the crop is grazed, or fed at the suitable time, the amount of feed will be more, but the crop will not be able to recover from the effects of grazing. For feeding as silage, bajra should be cut in the early flowering stage, the approximate yield of silage varying from 115 to 125 md. per acre. If utilized for making hay, the crop is harvested just before the flowering stage, yielding about 100 to 110 md. of green fodder per acre. When bajra is grown for grain the yield of dry fodder is 12 to 13 md. per acre.

SUITABILITY FOR FODDER : Bajra is a quick-growing, fairly cheap crop for fodder, it tillers freely, and it grows on a range of light soils. It is drought resistant and therefore needs less water than other fodder crops.

The yield of fodder is lower than that of Napier, *juar*, or maize and the quality is inferior too. When bajra is harvested for different purposes at the required stages, it makes a cheap, and fairly good stand-by, as a green fodder and silage crop.

In growing bajra for fodder, or silage, or hay, the following points should be kept in mind :

(*a*) An early-maturing variety, with a capacity to tiller well, and form full heads should be chosen.

(*b*) Fields are to be manured in the preceeding monsoon, so that there may be a residual effect, or the *zaid* (hot weather) crop should be manured with oil cakes and ammonium sulphate, or ammonium sulphate and super-phosphate if the last is required. Krishna Rao and Nambiar (1952) recommend a dosage of 224 lb. of ammonium sulphate plus 56 lb. of superphosphate.

(*c*) Plant more seeds per acre, at least double the amount required for grain, either drilling or dibbling them ; if the germination is heavier than required, the seedlings should be thinned, and early tillers removed.

(*d*) Have a source of regular supply of irrigation water and irrigate the crop to keep the soil at least slightly moist. When grown for the above purposes, plants should be sown closer than when sown for grain, giving dense growth so that the stems remain thin and succulent. The stage of growth influences the palatability and digestibility of the fodder.

Verbeek (1952) says that it is a valuable pasture crop, for high yielding milch and young animals. Experimental results at Vaalhartz (South Africa) show that Friesland cows fed on 20 lb. of lucerne hay and grazed on bajra pasture for four hours, gave good yields of milk. Pastures of bajra should be grazed in rotation and the grazed fields should be protected from grazing for 7 to 10 days, enabling the plants to make up the growth.

For silage of good quality the crop should be harvested in the early flowering stage when the nutritive value is highest. For higher milk production the animals should be given bajra silage together with hay and concentrates.

Hay can be prepared from bajra provided it is cut just before flowering, thus maintaining a low fibre content and at the same time providing palatable nutritive fodder, with a fairly high protein content. The required protein content of the concentrates to be fed is thus reduced to 15 to 18% of the total amount required.

USES OF BAJRA : (*i*) Grain which may be used for seed, gruel, flour, parched grain (*lava*), *kunthi* (a mash), and *pitha* (cakes). (*ii*) The plants provide fodder, green fodder silage, pasture, and hay, as well as being used for thatch and composting.

CHEMICAL COMPOSITION :

Worker	*Sample*	*Water*	*Protein*	*Carbo-hydrate*	*Fat*	*Fibre*	*Ash*
Church (Grain)	I	11.3	10.4	71.5	3.3	1.5	2.0
Aykroyd „	II	12.4	11.6	67.1	5.0	1.2	2.7
Wood	Straw	7.0	1.9	44.0	1.3	38.0	8.0
K. C. Sen	Milk stage fodder on dry matter basis	0	10.56	50.1	2.1	27.9	9.2

BOTANICAL DESCRIPTION : Bajra belongs to the Graminae family-tribe Paniceaa. It is closely related to *Pennisetum purpureum* (Napier grass) and *Cenchrus ciliare* (a grass locally called *anjan* or *banderia*). Plants grow to a height of 4 to 12 ft., tillering freely. The height is influenced by ecological and varietal factors.

ROOTS : Fibrous, shallow, more or less surface feeders, although some roots go deeper down and are thicker.

STEMS : Pithy, erect, with prominent nodes. At times auxilliary branches are given out which are weaker than tillers, growing to a height or of 2 or 3 ft.

LEAVES : The blades are lanceolate, tapering, and hairy on both sides, and feel rough. The sheath is slightly thicker than the lamina,

clasping the stem markedly. The lingule or rainguard is 4 to 5 mm. in length, whitish, and unevenly toothed.

INFLORESCENCE : A compound spike-like panicle, with an unbranched, tapering central axis, 6 to 14 in. long and 0.5 to 1.25 in. in diameter although there are varieties like the Jamnagar giant in which the panicle is approximately 28 in. long. The colour of the panicle on maturity varies from drab or dark greenish brown. The branches that bear the flowers (rachillae) contain 2 to 5 spikelets borne in fascicles of two, ringed around by bristles. Each of the spikelets has a couple of unequal glumes on either side of the floret enclosing it. The lower floret is staminate, the upper fertile. The seed box or caryopsis is enclosed by the lemma and palea. The infloresence bears two types of flowers : bi-sexual, which emerge first, and staminate which appear later.

After heading, the styles protrude out of the glumes and before they dry up, anthers come out. This type of inflorescence, i.e. with the emergence of styles occuring sometime before that of the anthers, is knows as protogynous, and helps secure cross-pollination rather than self-fertilization.

SEEDS : Small, 3 to 4 mm. long, weighting 3 to 10 mgm., slightly flattened on the side, nearly oval, tapering at the base and yellowish grey, blue, or greenish blue on ripening.

MAJOR DISEASES OF BAJRA : (1) Grain smut of bajra, caused by *Tolyposporium penicillare* Berfeld.

SYMPTOMS : Normally scattered grains are attacked, in severe cases a number of grains being affected. Sori of the fungus are in the ovaries of the affected grain, which is oval to pear-shaped, being half to twice the size of normal grains. Affected grains are dark green, brown, or dirty black when old and this colour is imparted by the membrane, which is tough and does not break easily. Spores are deep brown or black, spherical or angular. Infection is by airborne spores. Mehta (1951) found that the disease is not seed-borne. In case of a severe attack, a loss of 5% is caused. Mehta observed an infection of 15% at Kanpur.

CONTROL : Dr. Butler recommended (*a*) crop rotation and (*b*) collection and destruction of affected heads. Dr. Mundkar suggests (*c*) resistant varieties and (*d*) Agrosan G. N. dust, 3.0 chataks per maund, the seed being put with the dust in the duster and churned.

(2) *Downy mildew* or green ear disease, caused by *Sclerospora graminicola* (Sacc) Schr. This is widespread in certain years, causing much damage. Symptoms : streaks appear throughout the length of the leaf. Slight thickening of the leaf occurs, making it flattened and distorted. Older lesions are discoloured brown and fall away and ultimately the leaves are shredded. The ear is converted into a loose green head consisting of small twisted leaf-like structures. Stamens and pistal may be suppressed, or appear like leafy structures. The upper part of the floral axis forms a leafy shoot, while bristles of spikelets and fertile glumes become hypertrophied and green.

First the disease is soil-borne and then air-borne. It can be controlled as in the case of grain smut.

IMPORTANT PESTS : (1) *Juar* grasshopper (*Colemania sphenaroides* Bol.). It is also called the Deccan wingless grasshopper and causes severe damage, specially in South India. Subrahmanyan (1952) observed that the cycle of outbreaks lasts 10 to 15 years, the most damage being done in the 3rd and 4th years. This insect is a serious pest of *juar*, bajra, *kakoon*, and cotton. Leaves and young shoots are attacked and in severe cases most of the leaves are eaten away, leaving the bare midrib, or badly damaged basal leaf.

CONTROL : (*a*) Bagging of grasshoppers, (*b*) deep ploughing after the harvest of the crop, (*c*) dusting with BHC, 7-10% and (*d*) dusting with a mixture of Gammexane D.025 and wood ash in the proportion of 1:6 have been found effective.

(2) Red-headed or Gujarat hairy caterpiller (*Amsacta albistriga* or *A. moorei* Butl.). This is a major pest in Bombay, Gujarat, Ajmer, and parts of Chota Nagpur. In these areas over 90% of the plants may be eaten up and made leafless. Pruthi and Bebraw (1951) effectively controlled the pest by using light traps in the form of one 200 C. P. Petromax lantern for every 15 acres. Ranchandran (1951) found a mixture of 10% B. H. C. and Agrocide cotton dust effective. Handpicking of the pest is also suggested.

(3) The green stinkbug (*Nezara viridula*) is a minor pest.

(4) Blister beetles (*Mylabris* and *Cantharis* Spp.) cause some damage to the shoots and inflorescence.

IMPROVED VARIETIES OF BAJRA :

A/3 early, small seeded, bajri for fodder.

Gwalior 2 and 5, dual purpose.

T. 11, T. 16 and T. 55, high yielding, disease-resistant for grain purposes.

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METHODS IN MAIZE BREEDING

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Maize produces more useful pounds of material per man hour per acre than any other cultivated crop. It also furnishes inheritance studies with greater ease. And there are many other factors which have attracted the attention of cultivators and scientists to its improvement.

Be it a good or a bad point, it is a cross-pollinated crop, that is, the silk of any ear receives pollen mostly from *other* plants. The crop raised from seed thus produces individuals which show variation in all the measurable characters. Let us take the plant height. Within a small area one would find plants which would range all the way from dwarfs to very tall and sturdy ones. All the dwarfs are not dwarfs because they did not get enough to grow on, nor all tall plants so because they got enough nutrition but height depends on their inherent capabilities for tallness and dwarfness. Sturdiness is not all that is needed. The plant should be free from other defects. There are some very sturdy-looking plants which never develop any ear and remain barren. Some have ears but not silk. They do not produce any grain. There are others which have the tendency to lodge. Lodging is of two kinds. In the case of stem lodging the stem breaks down. If the breakage occurs *above the ear*, it does not cause extensive damage but when it occurs below the ear, the ear may fall on the ground and rot. Where the broken portion with the ear hangs on to the stem, development of grains is very much restricted. In the case of root lodging the affected plants bend over to various angles from the ground or even completely fall down. Lodging is greatly influenced by heavy rains and strong wind but only susceptible plants react to these influences. Besides these heritable defect there are many others, e.g., susceptibility to diseases and pests, open ear ends which give a good avenue for weevil attack, shrivelled seeds, premature germination, lethal ovules, which keep on propagating unchecked under normal open-pollinated conditions. Continuous attemps have been made by various workers to get rid of these defective characters and to select the high yielding types. Methods followed for improvement and the results obtained are given below briefly.

(a) Open Pollination Method

In this method of breeding, selection is directed primarily towards the female side without exercising much control over the pollen parent. Consequently selection is only half as effective and the hidden traits are carried over from generation to generation.

1. MASS SELECTION:

This consists of selection of good looking ears from the desirable plants of the main crop, "bulking" the seed thus obtained and planting them *en-masse*. Probably this method has been practised since maize has been grown. This type of approach has resulted in

modifying the plant type, ear type, maturity, and certain other characteristics suited to a particular locality in which selection has been practised, but not the yield. There are two primary reasons for this. As there is no control over the pollen parent the good looking plants receive pollen from all sorts of defective individuals also. The progeny resulting thus would contain some barren plants, some poor producers, and some good producers. That is, good ears cannot be reproduced by most of the progeny. To overcome the natural crossing by undesirable parents, if one starts removing all the defective plants it would take many hundreds of generations to remove them all, as the best looking individuals may contain the defects in masked condition and continue to reproduce them in the succeeding generations. The second reason for failure of this method is that the yielding ability is inherited in a very complex manner and it is very difficult to select plants only visually which would have high yielding ability.

2. Ear to Row Method of Breeding:

As selection based on the appearance of the plant and ear type was not sufficient to evaluate the yielding ability it was supplemented with the progeny-yield trial. Progenies from the best rows were subjected to further selection. Many modifications were later introduced to check self-pollination and prevent pollination from undersirable sources. However, selection carried over a number of years did not produce any appreciable increase in yield. Because the ears which produced high yielding progeny were chance hybrids of unknown parentage which could not be duplicated. Also, part of the progeny produced by the desirable ears were low in yielding ability. Selection as practised could not get rid of the undesirable traits. Hence, this method of breeding was also gradually discontinued.

3. Varietal Hybridization:

This consists of crosses made between the strains within a variety or between the two different varieties. In maize, each plant has a different genetic make-up. So each one can be called a strain though because of hybridity it does not remain constant. It was observed that crosses made between the strains of a variety did not yield more than the average of the variety. Crosses made between two varieties which differed in maturity and ear type often produced higher yield but there, too, the result obtained was confined to crosses between two certain specific strains. In general, higher yields were obtained where two parents were high yielders and differed widely between themselves. As the strains themselves were not constant, varietal hybrids never rose to the level of commercial significance.

(B) Controlled Pollination Method

In this method of breeding great care is exercised to pollinate manually under controlled conditions. A check is imposed both on male and female sides. When the ear shoot comes out, it is covered with a vegetable parchment bag before silking. The idea is that no foreign pollen can come and fertilise any of the silk enclosed. When silk emerges and forms a good tuft in the bag which can be seen through the bag or even felt between the fingers and when the tassel of the same plant starts shedding pollen, it is covered with a heavy kraft paper bag which is clipped to the peduncle, a day before pollination. Enclosing the tassel prevents pollen from the

other plants to come and lodge on it. Those which have already lodged before bagging die off during the period under enclosure which is about 16 to 20 hours. Next morning when the weather gets warm and the dew has dried up, pollen grains are shaken out from anthers by flapping the tassel bag and poured on to the silk of the same plant after removing the ear bag. The ear bag is then quickly replaced. This constitutes self-pollination or selfing. This is the closest type of inbreeding and works about three times faster than brother-sister mating in bringing purity of type. Pure parents produce progeny which are all alike in appearance and performance.

Self-pollination was started as early as 1876 by Darwin to study the effect of self and cross-fertilisation in maize. He observed that selfing induced low vigour in the progeny. As his experiments were not very extensive, not much information could be obtained from them.

Earlier experiments of Shull and of East and Hayes have contributed materials for establishing the basic principles of hybrid maize production, on a sound genetic basis. Shull's (1910) conclusions can be summarised as follows :

(1) Self-fertilisation leads to reduction in size, vigour, and productiveness in the progeny. Naturally cross-bred plants of the same variety are more vigorous than the self-fertilised plants. This reduction is evident with the progeny of the most vigorous plants as well as those which are poor in vigour.

(2) The greatest reduction in vigour is noticed with the first generation selfed progeny and it goes on diminishing with successive generations of selfing till a condition is reached where there is apparently no loss in vigour.

(3) There exist marked morphological and genetic differences between the self-fertilised lines originating from the same source.

(4) Cross-fertilisation between plants within a "family" does not bring any improvement in performance over self-fertilisation. However, cross-fertilisation between plants belonging to two "families", produces progeny which are as vigorous and high yielding as the non-selfed plants of the original parent variety.

(5) Reciprocal crosses between two selfed lines are equal in performance.

(6) The F1 hybrids are as uniform as their pure parents. The F2 shows greater variation than F1 and also lower yields.

He outlined a breeding programme in which he suggested selfing desirable plants for as many generations as was necessary to bring homozygosis, then making all possible single-cross combinations between the inbred lines and running yield trials. After the best combinations of inbreds were found, it would be rather easy to produce the commercial seed. He suggested also exchanging inbreds amongst the breeders so that they could be exploited most extensively.

It is quite amazing that Shull with his limited data laid out in the early days a frame work for a maize breeding programme, on which our present work is based. Recent researches have substantiated his findings and helped in evolving methods for cheaper seed production.

East and Hayes (1910) reported on the effects of self-fertilisation in maize. Their findings are quite in conformity with those of Shull.

Shull (1909) advocated the use of inbreds in single-cross combination for commercial purposes but still it did not seem to be a practical proposition as none of the inbreds were as vigorous as the parents with which inbreeding was started. Consequently, inbreds of low vigour produced small ears with small amounts of seed, no matter whether they were selfed or crossed on to another inbred or a variety. So, in 1918 Jones advocated the use of double crosses for commercial purposes, to overcome the difficulty of scanty and thus costly seed production. A double cross is a cross between two single crosses. Single crosses, being usually of high vigour and productiveness, yield rather well and thus lower the cost of commercial seed. Double crosses on an average yield lower than the single-cross parents because of the fact that it is hard to get four inbreds which would all combine very well with one another whereas it is relatively easy to find two inbreds which would give the best combination. It is because of economical seed production that double crosses are in commercial use.

CRITERIA OF SELECTION :

It is always advisable to start the inbreeding programme with a large number of selfed ears because in that way the probability of getting desirable inbred lines would be higher than when we use a small number. But it would be too tedious a task to carry them all through various generations of inbreeding. We must, therefore, have some means to discard the undesirable types at early stages.

Kiesselboch (1922) reported a general relationship between the yielding ability of inbred parents and their cross-bred progeny. This was substantiated by the findings of Richey (1924) that some inbreds were highly prepotent in transmitting high yielding ability to their progeny. Hayes (1926) observed that yield of inbreds was significantly correlated with characters which are measures of vigour.

Nilson-Leisner (1927) reported positive correlations between certain characters in inbred lines and the same characters in their crosses. In the studies of Jorgenson and Brewbaker (1927), positive and significant correlations were obtained for several characters in a group of inbred lines and their F1 crosses. Characters included in their studies are : yield, ear length, ear diameter, number of kernel rows per ear, plant height and seed weight.

Jenkin's (1929) report is in conformity with that of Hayes (1926). The former reported positive and significant correlations, within inbred lines for yield and plant height, ear length, ear diameter, shelling percentage and number of ears per plant. Within the group of single crosses also, positive and significant correlations were noted between yield and plant height, ear length, ear diameter, number of ears per plant, date of silking and tasseling, number of nodes per plant and number of nodes per plant

below the ear. High positive correlations were observed for the same characters between parents and progeny.

These observations show that one should select during segregating generations plants which are sturdy with strong root systems, thick stalks, broad leaves, one or more good ears, and other characters which are indications of good vigour. They should also show freedom from diseases and pests.

Even while selecting for high vigour one would not all the time be picking high yielding plants. It is quite expected as the correlations observed, though positive and significant, were not absolute. Cases have been met with exceptional results. Crosses between dwarf inbred lines have sometimes produced quite vigorous and high-yielding progeny. There are many other cases which have led some of the breeders to doubt the validity of visual selection. However, selection of characters which are desired in the progeny provides a good working basis.

TESTING OF INBRED LINES :

It is highly essential to find out which of the inbreds have high combining ability, that is, ability of good performance in crosses, as all the inbreds which have been visually selected for desirable agronomical characters would not have high combining ability. In earlier days people made all possible single crosses between the inbreds and selection was practised on the average performance of an inbred in various crosses. This method of selection was perfectly right but it involved a large amount of work. If one had 100 inbred lines he could make 4,950 possible single crosses [n(n-1)/2, where n stands for the number of inbreds involved in single crosses]. Making so many single crosses and running yield trials would be really quite a huge task. It seemed necessary to find some easier method of determining the combining ability.

Jones (1922) reported the results of inbred variety crosses. An inbred variety cross is a cross between an inbred line and an open polinated variety, which is not the source of the inbred. It is also called a top cross. He was interested in the relative performance of the crosses rather than finding a method for evaluation of inbred lines. Lindstrom (1931) in his extensive experiments with inbred variety crosses observed that some of the inbreds were highly prepotent, in transmitting disease resistance, ear type, lodging, and uniformity of maturity to their progeny. He advocated the use of such crosses for commercial purposes.

Jenkins and Brunson (1932) reported their extensive work on inbred variety crosses. They were interested in finding out the efficiency of this method for rapidly estimating the general combining ability of inbreds. They observed high and positive correlations between the mean performance of a series of single crosses and the performance of the same lines in inbred vareity crosses.

Johnson and Hayes (1936) made use of inbred variety crosses in predicting the general combining ability of inbred lines. Inbreds rated as poor combiners produced low-yielding single crosses. Similarly, lines rated as better combiners produced high-yielding single crosses. They suggested the need for many replications and running the yield trials at many locations so as to determine accurately in one year the combining

ability of inbred lines by this method. This has become a standard practice with the breeders for rapidly evaluating the combining ability of inbred lines.

TIME OF TESTING :

Jenkins (1935) and Sprague (1939) have advocated the use of early testing for greater efficiency in the production of desirable inbreds. This consists of selfing desirable plants of an open pollinated variety and at the same time crossing each one of them to a common parent called a tester. Inbred lines, or crosses or open polinated varieties which are non-related can be used as testers. The latter two, however, serve as better testers. Test crosses are run in yield trials. The inbred cultures are grown separatly and the best plants of each culture are selfed. Next year, on the basis of yield trial, selfed ears of the high-yielding parents are selected for further inbreeding. Final selection for general combining ability is made by the top cross method when the cultures reach the F5 stage.

Jenkins (1935) showed that inbreds acquired individuality in combining ability in a very early stage of inbreeding and remained stable through subsequent generations. Sprague (1939) reported that sufficient differences existed in the combining value of plants of an open-polinated variety to permit selection among them. Jenkins (1940) observed little variation in the combining value of plants within S1 progenies. These findings led to the advocacy of early testing. Rickey (1945), however, holds a differenct view. Genes for general growth segregate during early generations of selfing. Various correlation studies have shown that these genes also influence combining ability. Naturally, there is no truth in saying that combining value remains stable through successive generations of inbreeding. Test crosses provide good criteria for the estimation of combining value at any stage of the inbreeding programme. But, it does not provide any indication about the probable value when the lines would get fixed. Most of the discarded "families" through selection could be improved to the level of high yield as obtained from the selected "families". He indicated that early testing provided little gain with big effort.

Rickey and Mayer (1925) compared the yielding ability of the inbreds in crosses which were selfed for three generations and for five generations. They did not find any gain in combining value with inbreds selfed for five generations over those selfed for only three generations. This finding has been adopted and the top-cross test for general combining ability is made at the F4 stage, even now.

GENETIC DIVERSITY AND YIELDING ABILITY :

This refers to the genetic differences existing between the varieties which have become isolated from one another through some natural agencies, for a considerable number of years and undergone changes in their heritable matter. The value of genetic diversity was not known to the people of earlier days. So, they made crosses between lines originating from the same source. Naturally, the yield was not very encouraging.

Wu (1939), Hayes and Johnson (1939) and Johnson and Hayes (1940) presented data indicating that the related crosses yielded less than

the non-related ones. Studies of the groups of crosses, made by Johnosn and Hayes (1940) are illustrated as follows :

Group I	Inbred parents	A48 × H A9 × A26
		↘ ↙
No parent in common	Recovered lines in single cross	(A 94 × A102)
Group II	Inbred Parents	A9* × A26 A9* × A39
		↘ ↙
One parent (*) in common	Recovered lines in single cross	(A102 × A99)
Group III	Inbred Parents	A9* × A26† A9 × A26†
		↘ ↙
Two parents (* and †) in common	Recovered lines in single cross	(A102 × A11).

The single cross of the Group I had the highest yield and next in order of yield were the single crosses of Group II and Group III. They concluded that genetic diversity was as important or even more so than the combining ability.

Eckhardt and Bryan (1940) reported on the order of pairing the four inbred lines of which two, as for example A and B, came from one source and the other two, *e. g.* X and Y, from another source.

Inbreds paired in the order of (A × B) (X × Y) yielded decidedly more than the combination (A × X) (B × Y) or (A × Y) (B × X). That is the highest yield was obtained when parents of wide genetic diversity were brought together in a cross.

That yielding ability is inherited has been shown by Johnson and and Hayes (1940) and Cowan (1943). It is not a matter of heterozygosity or anything else. Inbred lines recovered from crosses between two low combining lines gave lower yield in single-cross combination than the lines recovered from crosses high × high or high × low.

PREDICTING THE PERFORMANCE OF DOUBLE CROSSES :

Making all possible double crosses and running their yield trial is an even more arduous job; with 20 inbred lines one can make 190 possible single crosses [n(n-1)/2 where n stands for the number of inbreds] and 14,535 possible double crosses [3n(n-1)(n-2)(n-3)/24 where n stands for the number of inbreds used in making double crosses.] Some simpler method of doing it seemed necessary.

Jenkins (1934) produced data on the relative merits of the four methods of predicting the performance of double crosses. The methods are :

1. Mean values of all possible six single crosses from four inbred lines, to be used in a double cross.

2. Mean values of four non-parental single crosses from four inbred lines. Parental crosses not to be included in estimating the performance would be those two single crosses which are to be used for double cross seed production.

3. Mean value of each inbred line in all possible single crosses. From these means the combining ability of a particular double cross is estimated.

4. Mean values of the top-crosses in which the four inbred lines have been used as parents.

Method 2 is based on a sound genetic basis and furnishes the best results. However, there are small differences in the predicting values of the methods 1, 2, and 3. Method 4 gave the poorest estimate among the four. The efficiency of method 2 has been checked by many workers. Single-cross parents were grown along with double crosses. Yields of the double crosses were found to be very nearly the same as predicted by method 2 from the yields of the 4 non-parental single crosses. So, method 2 has been followed for predicting the performance of double crosses. Also, other things being equal, the two low yielding single crosses out of six are used as seed parents.

MAINTENANCE OF INBREDS :

Great care is exercised to maintain the inbreds in pure form; otherwise they may run out by out-crossing and the whole process would have to be done over again. When inbreds get sufficiently homozygous, that is, by the F6 or F7 generation, they are subjected to alternate years of selfing and sibbing. Sibbing is done so as to produce a little amount of heterozygosity for vigour without affecting the combining ability of the line. The method is to select about thirty representative ears of an inbred line and to grow them in thirty short rows of about 15 feet each. Too rigid selection for a particular ear type should be avoided as that would bring in deterioration in the inbred line. Pollen from the plants of culture number one is collected, "bulked" and applied to the silk of plants belonging to culture number two. Similarly, "bulked" pollen from culture number two is applied to the ears of the plants of culture number three and so on. The pollen from the last culture is applied to the culture number one. After harvest, ears of different cultures are laid down separately at a place for inspection. Ears of those cultures which do not seem representative of the inbred line are discarded along with those from which pollen was taken for sibbing. Sibbed ears are shelled and "bulked". Next year they are grown and selfed. Commercial seed is produced by growing the selfed seed in an isolated plot. Out-crosses are very easily detected at an early stage. Their growth is very vigorous and they flower earlier. They are rogued.

PRODUCTION OF HYBRIDS :

Single cross seed is produced in an isolated plot. A high yielding inbred line is used as the female parent. The male parent in addition to other qualities must be a good pollen producer. The inbred parents are

grown in the ratio of one male to two female rows. When tassels start emerging, every day a man moves in the field and removes tassels from the female rows till tasseling is over. Seed harvested from the female rows is the true single-cross seed. Seed from the male rows is theoretically selfed seed but in practice has not been found satisfactory for commercial use.

To avoid pollination from other sources the crossing plot is bordered with 5 to 10 rows of the male parent. The greater the number of border rows the less would be the distance required for isolation. In the United States a minimum distance of 40 rods and five border rows is considered essential for isolation.

Double-cross seed is produced in the same manner as single cross. The ratio of female and male rows is usually 3 or 4 to one.

Where it is not possible to produce single-cross seed every year, advanced generation seed of single-cross parents is used in the production of double crosses. Advanced generation seed is the F2 or F3 generation seed produced from a cross in an isolated plot. The yield of such a double cross is the same as the one produced by crossing two single crosses. The disadvantage in the production of advanced generation seed is a reduction in yield in F2 and F3 generation when compared to F1. Neal (1935) obtained a reduction of 70.5 and 75.7 per cent in yields in F2 and F3 respectively in comparison to the F1 hybrid. There is some indication that biased selection in the production of advanced generation seed may also modify the performance of double crosses.

The second generation crop from a double cross also produces lower yield. Richey and his co-workers (1934) observed a reduction of about 15 per cent. For achieving the best results farmers should purchase the commercial seed every year from a source which is engaged in production of true hybrid seed. In the United States of America there is quite a good number of such seed companies doing business amounting to millions of dollars.

Why are hybrids better and why do they yield about 20 per cent more than an open pollinated variety?

The answer to this question may be given as follows :

(1) Greater production from each plant than an average of the open pollinated variety.

(2) Uniform production from every plant. Each plant would have one or more good ears.

(3) Greater freedom from diseases and pests.

(4) Ability to stand erect in adverse weather conditions.

(5) Even maturity which avoids loss due to rotting by excessive moisture in storage.

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THE NEWEST IN LITERACY TRAINING

BY

RICHARD W. CORTRIGHT

Literacy training of a kind never before offered any place in the world is going on at Allahabad. Under the leadership of Dr. Frank C. Laubach, the famous literacy pioneer, 40 men and women studied for a month, beginning in February, 1953. These students included social and adult education officers deputed by government bodies and Christian rural workers. A second group started work a few days after the first finished, and other classes are to follow. The courses are held at the Agricultural Institute and with the co-operation of its staff.

Working with Dr. and Mrs. Laubach are Mrs. Welthy Fisher, Miss Betty Mooney, Miss Margaret Runbeck, and Mr. Richard Cortright. It is expected that other experts will take part in later courses.

There are two distinct parts in the training program. The first is the teaching of literacy techniques. Dr. Laubach has revised these techniques many times in the course of his long and successful career in more than 234 languages in over 60 countries around the world. His newest method is called the picture-syllable-word method.

A set of wall charts in 5 colours contain the most common words in each language. The student goes from the known picture of a common object to the unknown writing of the name of that object by the superimposition of the first letter of the word on its picture.

The charts are reproduced in minature in the Primer. Next to these are easy sentences. Using simple substitution frames and pyramid patterns of sentence construction, the new literate quickly learns to read these easy passages in his own language. Dr. Laubach and his language committees have carefully limited the vocabularies to the most common and well known words of each language.

Following the Primer, the new literate reads about agriculture, sanitation and family uplift. In Hindi it is *Hoshiar Anand* (*Anand the Wiseman*). This is an Indian adaptation of the Burmese *U Sein the Wiseman* and the Arabic *Hussein the Wiseman.* In Gujerati Anand becomes Ramji ; in Bengali he is Kanai. Although the story-information remains the same, the name of the hero varies from language to language.

During both of the courses, literacy campaigns with these materials have been held in three nearby villages. The Laubach Literacy charts were placed on the walls of village homes and the primers and "Anand" books distributed to the adult illiterates. During the first course special emphasis was placed on Kharkoni were 5 afternoon classes were held for women, and 9 evening classes for men.

One of the trainees from Madhya Pradesh probably had more fun teaching than anyone else. The first night of the capaign he started teaching the illiterate village *mukhia* (leader), but the *mukhia* finished the primer

in four days, went on to finish the first book of the "Anand" series in the second week, and was reading well into the second book by the time the campaign ended after the third week. The *mukhia* nearly burned out his Petromax light with his enthusiasm for literacy.

The second part of the training is teaching the students how to write neo-literature (literature for the new literates).

First, the trainees are taught how to elicit pertinent information from experts. Many of the professors at the Agricultural Institute have graciously co-operated in this work. Mr. Frank Shuman, soil expert on exchange from the University of Illinois, explained how the lack of nitrogen in many Indian soils is a major reason for low crop yields. The result : a chapter about Anand and green manuring.

Mr. Roy Sellars, the Technical Co-operation Advisor to the Madhya Bharat government in Gwalior, explained how the need for water had been met in his province when more than 1000 wells were dug in Rajpur. Mr. Melancthon Alexander,—animal husbandry specialist also on exchange from the University of Illinois, told us how Anand could feed his cows to increase milk production. Mr. Brewster Hayes, horticulturist for the Institute, explained inarching and other ways of propagating good fruit trees. Mrs. A. P. Brooks, the Institute nurse, lent us her special talents in puppetry.—She is an expert in the production of "puppet plays with a purpose." One of her plays was the center of entertainment at the first Literacy Short Course Mela.

Miss Margaret Runbeck and Miss Betty Mooney have taught special courses in writing. Miss Runbeck is the author of 16 books and more than 200 magazines stories and articles. Her writing course was for simple journalism and the technique of article and short story writing. Miss Mooney led in the preparation of a village wall newspaper and the analysis of existing vernacular literature suitable for neo-literates. Out of the writing workshop many new chapters about Anand have been added. The following is Volume 9—Chapter 6, written in the first course :—

"Anand Learns About Locusts—and Neighbours."

Anand did not know how angry his neighbours were against him until the locusts came to his field.

It happened like this. Anand was in the house reading a letter and Sevati was working in her little flower garden. Suddenly he heard her shouting. He thought something must be hurting her. So he ran out of the house. She was too frightened to speak. She showed him the sky. And there angry and black was a storm of locusts. More locusts than he had ever seen together.

Sevati cried out, "Oh, Anand, they will eat our crops. Our beautiful green crops. What can protect them ?"

Anand's face looked frightened. We must destroy the locusts," he said, "There is no time to lose." Sevati said, "When I was a little girl, locusts destroyed my father's crops. We were hungry that year. We tried. to drive them away by noise."

Anand said, "Farmers in old times used to gather the neighbours to help make a big noise to frighten away the locusts. That only chased them on to the next farmer's crops. There are better ways to destroy them."

Sevati was getting together dried grass and sticks. "I will make smoke to drive them off," she said.

"There are better ways than smoke," Anand cried. "I will get the farmers to come and help us."

He ran to a neighbour's house. The neighbour said he could not come. He ran to another house. The same thing happened. Suddenly he knew there was trouble. They did not want to help him.

He asked them, "Don't you want to help me ? My farm will be destroyed if I do not have help."

"Get some Harijans to help you," one neighbour said. "You and your son like Harijans. Maybe you should not live in our village. Maybe you should live with the Harijans in their village."

This hurt Anand to the heart but he could not talk with them now for the locusts were eating his field. He ran home and worked by himself, digging a trench. Sevati helped him. He did not want to tell her that the neighbours were against them. But he could see by the look on her face that she knew and was hurt. Their hearts were very sad as they worked.

Sevati said, "Locusts lay eggs in hundreds. They lay them on the ground like chickens. Their babies come out in about three weeks. We must destroy them before they lay eggs."

Serindar, their fine son, came home from a visit to the city and went to work digging. "Where are the neighbours ? They must help us", He said suddenly.

"We have no neighbours now," his father said. "They are against us."

Serindar knew that it was because of Tara, the Harijan girl and he felt hurt.

When the trench was long enough they put sticks and grass into it. They put kerosene into the sticks and grass because the locusts had gone there. Then they set fire to the kerosene.

Anand's book also told of other ways to destroy locusts. If there is no kerosene then earth can be put on the locusts in the trenches and this will kill them. The book also said that the crops can be dusted with gamexene which is poison to the locusts and the babies.

At the end of the frightening day Anand fell upon his bed hurt and sad. He knew that the locusts would not eat his green crop. That had been prevented by hard work.

But he had a big trouble in his heart. The neighbours who used to love him now had turned against him. Nobody in Anand's house

could sleep. Each was sad because this trouble had come. Each loved Tara, the Harijan girl, but they loved the neighbours also. They wanted the neighbours to know how they thought.

NEW WORDS : "locusts, suddenly, hurting, sticks, grass, smoke, kerosene, maybe."

These training courses are part of the All-India drive against illiteracy. Dr. Laubach and the literacy team are working with the Technical Co-operation Administration and the Indian government. Beside conducting literacy and neo-literate training centers like the one on the campus of the Allahabad Agricultural Institute, the team is actively engaged in producing literacy materials in the eleven major languages of India.

In December Dr. Laubach addressed the third Annual Indian Adult Education Conference on neo-literature at the Jamia Milia Islamia outside Old Delhi. At this conference Dr. Ranganathan of the Madras Christian College called attention to the vast implications of the neo-literature. When many more of the 82% illiterates of India learn to read, there will be profound changes in the life of the nation. Dr. Laubach himself believes that India will become literate. He knows what his Primer can do ; and he knows how much the illiterates want *Anand.*

The spirit of the Allahabad Agricultural Literacy Short Course is written in Dr. Laubach's 1940 *India Shall Be Literate.*

"If this is an hour of new hope for India, it is especially so for the millions of illiterates.....For these people are not only illiterate, but they are the victims of the hard-hearted men who prey on their ignorance..... They are hungry, driven, diseased, afraid of the unknown in this world..... These illiterate people never had a delegate anywhere, have been voiceless, the silent victims, the forgotten men.....Now through the power of reading and the vote, they shall be heard."

American farmers are recently using more and more anhydrous ammonia as a source of chemical nitrogen for use as a fertilizer. Anhydrous ammonia is pure ammonia gas liquified by pressure and stored under pressure in steel cylinders until used. It is particularly suitable for use under irrigation conditions. The gas is released in small steady flow by bubling the gas under water in irrigation channels. The gas dissolves readily in the water forming a very diluted solution of ammonium hydro-oxide with almost no loss to the air. The water carries the nitrogen of the ammonia to all parts of the fleld with no additional labour cost. It reacts in the soil form stable compounds which are not lost as the water evaporates, and are slowly nitrified to forms readily absorbed by crops, Ease of application and the concentrated nature of the original anhydrous product, meaning low freight and handling costs per pound of available nitrogen, are attractive features. The steel cylinders can be returned to the factory for refilling when empty.

EFFECT OF TIME OF TURNING UNDER SANNHEMP AS A GREEN MANURE, WITH AND WITHOUT FERTILIZERS, ON THE YIELD OF WHEAT

By

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Introduction

The agricultural soils of India are deficient in nitrogen and organic matter. The average nitrogen and carbon contents of Indian soils are 0.05% and 0.6% as against 0.1 to 0.17% and 3% of American and European soils (Mukerji and Agarwal 1950). It is imperative, therefore, to incorporate both carbon and nitrogen in the soil before taking any crop.

There are many forms of organic manures but the most easily available for use are :

(1) Farmyard manure
(2) Town refuse or compost
(3) Oil cakes
(4) Green manures.

(1) *Farmyard manure :* The supply of farmyard manure is limited and is insufficient to meet the manurial requirements. Most of it is used as fuel.

(2) *Town refuses or compost :* Collecting refuse and making it into compost is not at present the common practice, as the process is a long one and difficult too.

(3) *Oil cakes :* These form another good source of nitrogen for the soil but as some of them are fed to cattle, they are scarce and costly.

(4) *Green manure :* Green manuring, therefore, seems to be the cheapest and best way of supplying nitrogen and organic matter to the soil for maintaining and improving soil fertility (Gadgil 1937).

Green manuring consists in ploughing in any green crop for the purpose of maintaining and improving soil fertility. Much work has been done on the various type of green manure crops in India but sannhemp (*Crotolaria juncea*) is the most popular.

The age and time at which a green manuring (sannhemp) crop is to be buried is one of the important factors to be considered. With this idea, an experiment was laid out to study the effect of the time of turning under a sannhemp crop when done after 4,6,8 and 10 weeks of growth, in conjunction with fertilizers.

Review

Colemn *et al* (1912) reports that a green manuring crop should be buried when it attains the flowering stage. Howard (1914) suggests that Sannhemp should be turned under by the 15th of July. Singh (1936) found

that the best stage for burying sannhemp was 75 days after germination. Sethi and Chatterji (1949), while reviewing the green manuring work of U. P., mention that ploughing in sannhemp after 7 to 8 weeks of growth was better than earlier buryings.

Howard (1914) recommends that 2 months should be allowed for its proper decomposition between the burying of a green manure and the sowing of a succeeding crop. Allan (1915) also supports the above recommendation. Hutchinsons and Milligan (1914) have shown that a decrease in nitrogen contents starts 8 weeks after incorporation. They also observed that nitrification in the soil was the same in the case of 4 and 6 week-old plants but was less in 10-week-old plants. Joachim (1926) showed that accumulation of nitrates took place between the 6th and 8th week after incorporation.

Experimental

The experiment was designed on a split-plot basis with 4 replications and the following treatments. :

Main plot

A – Sannhemp buried after 4 weeks
B – Sannhemp buried after 6 weeks
C – Sannhemp buried after 8 weeks
D – Sannhemp buried after 10 weeks

Sub-plot

T – Control

X – Superphosphate, 80 lbs. P_2O_5 per acre at the time of sowing sannhemp.

Y – Ammonium sulphate 15 lb. N per acre at the time of burying sannhemp.

Z – X+Y

Rotation : Green manure (sannhemp) - wheat

Results

TABLE I

Total green matter and nitrogen added

(1950-52)

Treatments	1 Total green matter in lb/acre	2 % of nitrogen in plants (dry basis)	3 Total nitrogen added in the form of green matter in lb/acre	4 Total nitrogen in soil before sowing wheat	5 Total nitrogen in soil after wheat harvest	6 Difference (4-5)	7 Inerval between burying and sowing wheat
A	12604	2.699	51.06	0.070	0.064	0.006	85 days
B	19763	2.586	88.41	0.088	0.055	0.033	72 ,,
C	31460	1.669	120.76	0.081	0.063	0:018	59 ,,
D	37913	1.321	125.12	0.068	0.052	0.016	44 ,,

TABLE II

Yield of wheat in maunds per acre (1950-51), *following sannhemp sown in July* 1950.

	X	Y	Z	T	Average
A	20.67	19.58	18.49	16.91	18.91
B	17.39	17.51	18.24	16.54	17.42
C	25.42	21.16	23.84	12.11	23.38
D	20.07	16.30	18.49	15.57	17.63
Av.	20.89	18.67	19.76	18.03	

Main plot significant at 1% C. D.-4.71

Sub-plot significant at 5% C. D.-1.89

TABLE III

Yield of wheat in maunds per acre (1951-52) *following sannhemp sown in July* '51.

	X	Y	Z	T	Average
A	15.81	12.92	16.26	12.03	14.25
B	12.03	10.02	13.81	9.58	11.36
C	20.05	14.26	22.94	17.60	17.54
D	16.04	13.81	17.60	11.36	14.70
Av.	15.98	12.75	17.65	11.47	

Main plot significant at 1% C. D.-2.75 mds. per acre

Sub-plot significant at 1% C. D.-2.82 mds. per acre

From Tables II and III it is clear that significant results were obtained by burying sannhemp after 8 weeks of growth. This treatment was significantly superior to the rest.

Discussion

It would appear from Table I, that the total green matter and nitrogen added in the form of green matter were more in the later burying than the earlier ones.

The total nitrogen present in the soil at the time of sowing wheat was the highest in the case of B followed by C, A, and B, but the grain yield was higher in C than in A, B, or D. This might indicate that the available nitrogen in treatment B may not have been utilised by the crop and lost during the early stages, while in the case of C it might not have been so.

The lower yields in treatment A and B may perhaps be due to long interval of 85 and 72 days between burying and sowing of wheat crop. The interval was 85, 72, 59 and 44 days in the case of A, B, C, and D. Also the total organic matter was comparatively less in A and B than in C and D.

The highest yield was obtained in treatment C in which the interval between burying the manure and planting the wheat was 59 days (approximately 8 weeks). This finding agrees with that of Howard (1914). Hutchinson and Milligan (1914) have also shown that a decrease in nitrate contents starts 8 weeks after burial.

The cause of the lower yield in D as compared to C might perhaps be due to a shorter interval (44 days) between burial and sowing of wheat.

It is, therefore, presumed that the interval between burying and sowing of a succeeding crop has a direct bearing on the yield of the latter. The optimum interval found was 8 weeks.

Summary and Conclusion

Sannhemp as green manure should be buried when about eight weeks old, and the interval between burial and the sowing of wheat should also be about eight weeks. Although the interaction between green manuring and fertilizers was not found to be statistically significant, it is suggested that under the conditions of this experiment, a combination of 15 lb. of N with 80 lb. of P_2O_5 per acre, or the latter alone, may result in higher yields.

RELATIVE EFFECT OF DIFFERENT FORMS OF GREEN MANURING ON THE YIELD OF WHEAT

By

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In a hot climate, which prevails throughout the year, the organic matter of Indian soils burns like fuel. Unless it is continuously replenished the land cannot remain in good heart, as is evident from the low yields generally obtained from crops. Of cattle-dung, a major source of organic and nitrogenous manure, two thirds is converted into smoke and the third left is so badly stored before use that it loses most of its nutrients. The fate of night soil is worse still, as the Indian farmers are prejudiced against its handling. In this way the plant food removed by crops does not find its natural way back to the soil.

We must, therefore, give the soil all it requires, not only to produce now, but to remain rich for ever. The other sources of organic nitrogen are oilcakes and green manures. Due to high prices and difficulty in procurement, the use of oil-cakes is limited to cash crops only. Until the range of production is so increased as to make it available at a cheap rate everywhere, there is not much chance for its great utilization.

Green manure, therefore, is the cheapest and easiest method of building up soil fertility and thus increasing the yield. It affords a simple method of manuring both on heavy and light soils, and requires no live stock. This can with advantage be practiced on mechanised farms.

The humus compounds resulting from the decomposition of green matter increase the absorptive capacity of the soil and promote aeration, drainage, and granulation – conditions that are extremely important for plant growth.

Besides improving the physical condition of the soil and the store of soil organic matter and nitrogen, the added green material acts as food for soil organisms which in turn supply a great quantity of plant nutrients by their own decay and by bringing unavailable nutrients in the soil to the available form.

The practice of green manuring, however, is rendered difficult by climatic and economic causes. Green-manure crops need a quick and certain start during the short period available for their growth. This can be achieved if the season is favourable. Lack of moisture, both at the time of growth and after burial, is harmful.

The economics of green manuring from the point of view of the small cultivator will largely depend upon the possibility of producing the green manure crops without disturbance to those main cash crops which support the finances of the cultivator.

Experimental

It is difficult to control the climate but not economic factors. Keeping this in view an investigation to see whether sann-hemp grown in an-

other field, such as waste lands and incorported in the cultivated field direct, or after composting would produce the same effect as green manure grown *in situ*, carried out in the top block of I. A. R. I. farm at Delhi. The results reported in this paper relate to the years 1948-50 under a rotation of green manure-wheat-maize-wheat.

The experiment was designed on a split-plot model with 4 replications and the following treatments :

(*a*) *Main Plot :*

A – No green manure

B – Sannhemp grown *in situ* and buried.

C – Sannhemp brought from outside and buried at 200 maunds per acre.

D – Sannhemp brought from outside, composted and later buried at 200 maunds per acre (on the basis of green weight).

(*b*) *Sub-Plot :*

O – No manure.

N – Ammonium sulphate at 40 lbs. N per acre at the time of sowing wheat.

P – Superphosphate at 80 lbs. of P_2O_5 per acre at the time of burying sannhemp.

NP – Ammonium sulphate at 40 lbs. N per acre at the time of sowing wheat and superphosphate at 80 lbs. P_2O_5 per acre at the time of burying sannhemp.

Results

The yield of wheat (C518) grain obtained during 1948-49 is given in the following table :

TABLE I

Average yield in maunds per acre

Treatments	O	N	P	NP	Av.
A – No manure	11.64	15.77	11.22	21.79	15.10
B – Sannhemp grown in *situ* and burried.	18.92	18.80	20.21	25.24	20.79
C – Sannhemp brought from outside and buried (200 mds. green wt. per acre)	13.18	17.39	10.70	24.79	16.52
D – Sannhemp composted and buried (200 mds. green wt. per acre)	13.95	13.92	17.14	25.40	17.62
Average	14.43	16.48	14.82	22.24	

Main plots significant at 1% level C. D. – 2.54-5%, 3. 65-1%
Sub plots significant at 1% level C.D. – 3.06-5%, 4.10-1%.

The subsequent crop of maize failed due to rain and water-logging ; hence the data could not be obtained. This was followed again by wheat in order to study the residual effect of manure applied in 1948. The yield of grain is given below :

TABLE II

Average yield in maunds per acre

Treatments	*O*	*N*	*P*	*NP*	Av.
A	7.51	9.55	7.06	8.53	8.41
B	12.90	8.00	11.19	12.37	11.11
C	6.08	10.41	10.66	10.09	9.31
D	8.62	13.60	8.66	14.33	11.29
Average	8.78	10.31	9.64	11.33	

Main plots, not significant

Sub-plot, significant at 5%

C. D. – 1.77 5%

2.38 1%

Discussion

It is evident from the above tables that green manuring, irrespective of form, leaves a residual fertility in the soil even after two crops have been taken.

If the effect of fertilizers used in conjunction with green manures is eliminated the highest yield in both the seasons was obtained from sann-hemp grown *in situ*. This explains the dominant part played by roots in building up fertility in spite of the advantage of transferring moisure and minerals in case of material brought from other plots and used. The picture, however, becomes slightly different when artificials are used, due perhaps, to their effect on the decomposition of organic matter and greater mobility of plant nutrients. The overall superiority of sannhemp grown at the site which is significant in the first crop becomes less so in the second season.

The slight increase in residual fertility of sannhemp composted and buried may, as Acharya *et all.* (1946) obesrved, be due to nitrogen fixation from the air. Pieters (1917), reviewing green manuring experiments in the United States, found, sometimes, a larger increase in the succeeding crops by turning under a leguminus crop.

Summary

From the investigation it appears that green manuring, irrespective of form, leaves residual fertility in the soil even after two crops have been taken from it. This may amount to giving 12 to 33% more yield over the check in the second crop.

The application of sannhemp after composting is recommended when it is not possible to do green manuring at the site.

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F A O Development; Paper No. 32, Small Farm Implements, 1953. Concludes,—In many regions of the world, the use of improved hand tools and light, animal-drawn implements and the application of better harness are certainly among the best methods of increasing the effectiveness of work on small holdings and the efficiency of the cultivator's labor, thus permitting higher yields from the limited arable land at the disposal of the small farmer.....

Descriptions of a selected number of useful small tools has demonstrated the principles governing their design and utilization and the possibility of their further improvement, and shown that remarkable results can be obtained with very little effort and by simple means.

United States farmers increased use of commercial fertilizers by 6% in 1951-52 over the amount used in 1950-51. There is a trend towards use of high analysis, more concentrated forms of fertilizer. Nearly three fourths of all commercial fertilizers used were of the blended on mixed grades mostly mixtures containing the three plant foods, nitrogen, phosphorus, and potassium.

The minor or trace elements which have been given much prominance in relation to crop production in recept years have no magic or tonic properties as some have thought. They are true plant nutrients. as necessary as nitrogen, phosphorus, or potash. But the amounts in which they are required are so small that in some cases they were overlooked for many years because of the inability of research workers to refine their chemicals to the degree needed to produce a deficiency effect.

The use of plant hormone sprays to reduce the natural falling of fruit just before it is harvested has become common in some countries. Different fruits respond to different hormones. For some varieties of apple, naphthaleneacetic acid is best, while for other apples and the citrus fruits, 2, 4-D and 2, 4, 5-T have proved more effeetive. Several other hormones are showing promise. In some cases the hormone result in fruit of larger size, and better keeping quality, but sometimes the opposite is true. Some of these substances are also used to kill weeds, and care must be taken to avoid solutions strong enough to damage the plants. When used as recommended, commonly at 5 to 15 parts per million, they are harmless.

WALNUT GROWING*

The Persian walnut (*Juglans regia*), more commonly known as the English walnut, is rather exacting in soil and climatic requirements. When growing under good conditions, however, the mature tree is large, shapely, and productive.

CLIMATIC CONSIDERATIONS : The chief climatic limitations to successful walnut culture are frosts and extreme heat. Spring frosts may destroy the flowers or small nuts, while extreme heat during the summer may cause sunburning of the nuts to such an extent that the crop may be materially reduced. A temperature exceeding 100 deg. in early summer, or several degrees of frost at blossoming or fruit setting time, may prove harmful to nut production.

Generally it could be said that an average of 30 inches of rain or irrigation is required for successful nut production, but factors such as soil type, climate, age and spacing of trees would influence the results. The walnut tree is large, with a big leaf surface, and consequently requires an abundance of soil moisture through the growing period.

SOIL REQUIREMENTS : To produce large, long-lived trees capable of maximum production, the soil must be of good depth, loamy and rich in organic matter. Shallow soils and deep sandy soils are unsuitable. It is impossible to judge the suitability of a soil from an inspection of the surface – the subsoil is important in the matter of its suitability for walnut production. The walnut tree is deep rooted and the soil and subsoil must be such as to provide for deep penetration of moisture.

Good drainage to a depth of about 10 feet is considered a requirement for the walnut. The trees are readily injured if much alkali is present, so that in addition to the necessity for good drainage, the quality of irrigation water is also important.

VARIETIES : The majority of walnut trees growing in New South Wales are seedlings and there is a considerable variation in the quantity and quality of nuts produced from these trees. The fruit from a seedling tree is seldom identical with the parent, and in fact is generally inferior. The planting of trees of specific varieties which have been produced by budding or grafting, on seedling stocks, is imperative if the trees are being planted for commercial nut production.

Bacterial blight, which is by far the most destructive disease affecting walnut trees, is rather common in most parts of this State and difficult to control. As some varieties are more susceptible to the disease than others, it is desirable, especially in the higher rainfall areas, that the least susceptible varieties should be planted. The following varieties are suggested : Franquette, Concord, Payne, Eureka, Freshford Gem, Traill.

Some varieties of walnut are self-fertile. The staminate flowers are produced in long catkins which contain an abundance of pollen which is mostly windborne to the pistillate flowers. Heavier crops are susually

*Issued by Australian Government Trade Information Service, Box 217, Bombay, 1.

carried where two or more compatible varieties are planted in close proximity.

PROPAGATION OF TREES : Experiments have been carried out in New South Wales in methods of propagation, and the results of both budding and grafting have been very irregular and unsatisfactory. Work carried out at East Malling Research Station, Kent, England, has shown that the variable climatic and other conditions were such that the propagation of walnut trees in the open was not recommended, and a method of raising these trees under glass has been evolved.

In Australia few nurserymen can claim commercial success in propagating walnut trees ; the percentage of "takes" is small and consequently the price of trees to the grower is high. However, the purchase of trees from nurserymen is probably more economical when possible loss of time and eventual failure to produce trees is considered.

In New South Wales, seedlings of the North California Black Walnut (*J. californica.* var. *hindsii*) has been found the most suitable stock for walnut propagation.

Walnut stocks are easily raised, as the nuts germinate freely and usually make strong growth. The seeds should be planted in well prepared, fertile soil of good depth. They should not be allowed to suffer from lack of moisture and must be kept growing vigorously. The stocks should have attained a diameter of at least one inch before grafting or budding is carried out.

Wood for grafting scions or buds should be taken from healthy and vigorous trees during the dormant period and properly stored at a temperature of about 40 deg. Well formed two-year-old scion wood appears to give best results.

For grafting in spring, when the stocks are showing first signs of growth, the whip and tongue, oblique cleft, or wedge graft may be used. In New South Wales the whip and tongue graft has proved the most successful.

"Patch" and "shield" budding in late summer or early autumn have given indifferent results.

PLANTING : When lifting trees in the nursery, care is necessary to ensure that the long taproot is not unduly injured, and when planting a fair-sized hole will have to be dug. Watering the newly planted tree before the hole has been completely filled in, is advised.

The distance apart at which trees should be planted will depend mainly on soil and climatic conditions. Under ideal conditions probably 50 feet between trees will not be too great. In America the highest producing trees are planted 60 feet apart. Under less suitable conditions probably 40 feet between trees will be satisfactory. The number of trees per acre would be :

40 feet × 40 feet – 27 trees.
60 feet × 50 feet – 17 trees.
60 feet × 60 feet – 12 trees.

With any of the above spacings, and particularly with the wider plantings, only a small portion of the orchard land is being utilised during the early years of tree growth. Under these circumstances, it would be profitable to use filler trees or inter-crops of some description.

PRUNING : Following planting, the trees should be headed to a height of about 5 feet or 6 feet from the ground. If the trees are not high enough for heading, they should be left untopped for a year or until they are sufficiently high, when the top can be cut or pinched off at the required height. From this stage onwards, pruning is light and consists mainly of the removal of shoots from the lower portion of the tree, and shortening any leaders which may be outstripping the others or limbs which are crossing or causing overcrowding.

Until such time as the walnut tree has made sufficient top growth, the long stem is exposed to the sun. Where temperatures are likely to be high it is advisable, for the first two or three years, to protect the trunk from sun scald. This can be done by using a loose wrapping of hessian, tree guards, or by white-washing several times through the summer months.

CULTIVATION : No hard-and-fast rule can be laid down in the matter of cultural operations to be followed. Sound cultural practice in one district or one season may be quite poor practice in another district or different season. The continuous stirring of the soil is detrimental, but some cultural treatment must be carried out to prevent the loss of soil moisture mainly brought about by excessive grass or weed growth.

Walnut trees require plenty of water and deep penetration. This would suggest two practices, firstly a deep late winter ploughing to increase penetration of water ; and secondly, some control of the green matter between the trees during the summer months to reduce loss of soil moisture during the period of the year when the trees require it most.

Generally it can be said that the walnut tree requires the same amount of attention in this regard as do other fruit trees.

HARVESTING : When the walnuts have reached maturity, the hulls split open to release the nuts, which are allowed to fall on the ground. The fall of nuts can be hastened by poles with hooks on the ends for use when shaking the limbs prior to picking up. The nuts should not be allowed to remain on the ground for a lengthy period during showery weather, otherwise loss of colour, and in some cases mouldy kernels, may result.

Some of the nuts when picked up will not be entirely free of adhering hull and there will be a percentage of "sticktights" from which some difficulty may be experienced in removing the hull. These "sticktight" nuts should be separated from the main sample, as there is generally a high percentage of inferior nuts amongst them—undeveloped, mouldy and discoloured kernels.

After hulling, if the nuts are dirty, it will be necessary to wash them, then dry thoroughly and as quickly as possible. Drying can be carried out in a dehydrator or the nuts placed in shallow slatted trays and dried in the sun on low racks to allow ventilation. The nuts on these trays should be stirred frequently and covered during wet or very hot weather. Any extremes in temperature will cause splitting of the nuts. Slow drying pro-

longs the process, but prevents splitting. When the nuts are nearly dry, they should be stacked for final drying.

Bleaching is recommended for the preparation of a first-class product. The following bleaching solution should be satisfactory : chloride of lime 25 lb., sal soda 18 lb., dissolved in 50 gallons of water, sulphuric acid being added to the clear liquid (which has been drawn from the settlings) at the rate of 1 1/4 lb. to 425 lb. of solution. The walnuts should be immersed in this solution for from 5 to 10 seconds.

EDITOR'S NOTE : WALNUTS IN INDIA.

While the walnut cannot be grown in most parts of India, it is a crop of some importance in the Himalayas. Its greatest development has been in Kashmir, where a number of types have been identified. The species is probably indigenous to the area from Kashmir to Iran. The walnut occupies more land in Kashmir than any fruit except the apple, and it is grown to a less extent in the Kulu valley, Garhwal, and Kumaun.

As in Australia, propagation has proved a difficult problem in Kashmir, where no satisfactory vegetative method has been found. As a result, the nuts produced vary greatly. Some are of excellent quality, and others have such thick shells as to be of little value. Inferior nuts are sometimes used only as a source of oil. The wood is also valuable, being hard, with a beautiful grain. Much of the finest wood-carving in Kashmir is on walnut. The crop is particularly suitable to those parts of the hills where transportation difficulties make the marketing of fruits uneconomical. Walnuts keep well for several months, and are comparably light, so transport is not a great problem. If a satisfactory means of propagation is found, the industry is likely to extend considerably.—W. B. H.]

Work by the Department of Agriculture, Uttar Pradesh has shown that the common parasite, dodder, can be killed by spraying it and its host with certain homone weed killers. The damage to the host varies with its species, but may not be great. As the doddor will eventually kill the plant if left alone, and as the alternative method of control is to remove all branches which have been attacked, spraying offers a promising way of fighting this pest.

Mango breeding, which is being carried on at several places in India, requires great patience. At four stations it was found that on the average 112 flowers must be hand-pollinated in order to get one hybrid plant—and it might die before fruiting, or turn out to be worthless.

Poor seedling mango trees on the Pachmarhi plateau are being top-worked with good varieties in large numbers. Crown grafting is used during the rainy season, or shield budding in November to January.

The best tree for windbreaks in tbe Punjab is a common jungle tree, *Terminalia arjuna*, according to tests begun at Attari in 1938. The *semal*, The *Bombax malabaricum*, was considered second best. Both grow well and easily throughout northern India.

BOOK REVIEW

PLANT PROTECTION IN INDIA : Second edition, 1952, published by Imperial Chemical Industries India Ltd., Calcutta, Bombay, Madras, Cochin, New Delhi, Kanpur. 119 pp. Illustrated. Distributed on application to Publishers.

This booklet deals with pests and diseases of crop plants and their control. It also furnishes up-to-date information on plant protection material and equipment. Description of each pest and disease is given in such a way that it is very easy for the layman to identify them. Drawings and other illustrations aid the farmer in identification. The contents of this booklet are divided into ten sections as follows :

Recent Advances in Plant Protection ; The Action and Use of Plant Protection Material ; Disinfestation of Stored Products with 'Gammexane' BHC and 'Killoptera' ; Description of Plant Protection Materials and their Use ; Hints on Spraying and Dusting ; Common Inssect Pests and their Control ; Common Fungous Diseases and Their Control ; Weed Control ; Spraying and Dusting Equipment and the Alkali and Chemical Corporation of India Ltd. Each of these sections consist of a number of small articles concerning the main topic along with very good illustrations. Towards the end of the book a list of crop pests, their description and methods of control are given in tabular form. Following this a list of crop diseases, their symptoms and control is also given. These two lists are extremely useful for quick reference. There is also a section on control of weeds and in this section a list of common weeds and their control is furnished.

The major need in this country is increased food production. It has been estimated that pests and diseases destroy about 10 to 15 percent of the crops. By applying the methods recommended in this booklet it should be possible for the farmers in this country to minimise these losses. Therefore this book is bound to prove very useful in the fight against pests and diseases. For the agricultural scientist it is a very useful book for reference and for information regarding the latest plant protection materials and equipment. It is also a source book to agriculturists and extension workers who are constantly receiving requests for help in plant protection.

W. K. W.
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D D T has proved an excellent insecticide for the mango hopper, the most serious pest of the mango in India. However, it interferes with the biological control of other insects, and many cases have been reported in which treatment with D D T was followed by serious outbreaks of mites. Mixing sulphur with the D D T helps to control the mites and also mildew. In some cases the use of D D T has allowed the population of scale insects to increase, and these are very difficult to control chemically.

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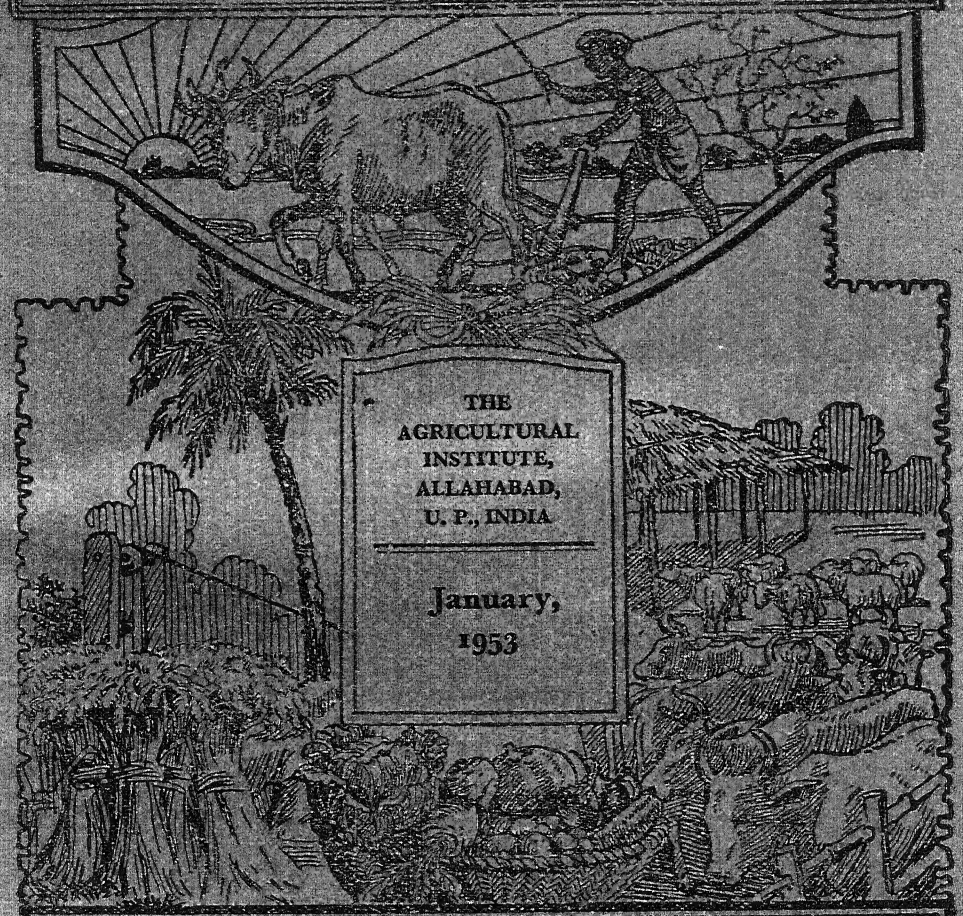

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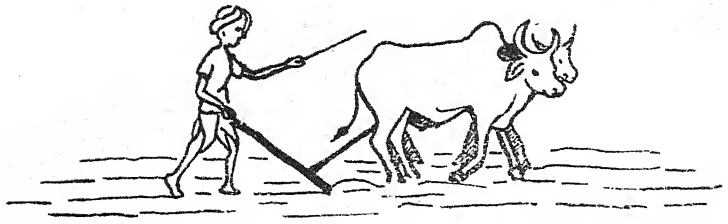

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CATTLE TO HONG KONG

By

S. R. Biswas, I. D. D., G. V. Sc.

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In 1950 an inquiry came to the Principal of this Institute about the possibility of our helping to purchase and ship 100 head of young zebu cattle to Hong Kong for breeding purposes. The inquiry was forwarded to Mr. James N. Warner, Head of the Animal Husbandry and Dairying Department. Later, these requirements were reduced to only 12 head; the preference was for the Kankrej breed. It was required that eight of these cattle be females and four males, all below two years of age. The number was reduced primarily because various practical difficulties were envisaged with such a shipment abroad. The actual shipment of the 12 head did not become possible, however, until the summer of 1952.

This article is a record of the various difficulties and problems that were faced while handling this shipment. It also tells something of the valuable experience I gathered from being assigned to handle it.

The importers authorised the nomination of an agent, if necessary, to get the job done. With the approval of the Institute authorities, I was given the opportunity to manage the shipping and other arrangements and to accompany the animals to Hong Kong. Sufficient funds were made available for the project by the importers.

Efforts were made to procure a permit from the Government of India for this export, and quite a time elasped before we could actually get it.

We got in touch with practically all shipping and steamer companies whose addresses we could get from various sources. Most of them refused

to undertake this shipment of cattle, while others made various promises. No two different shipping agents would negotiate beyond a certain point for handling the same shipment. For this reason we had difficulty finding what might be the best service for handling the shipment.

At the outset we had two alternatives before us, to ship the animals either through Calcutta or through Bombay. There are direct steamer services to Hong Kong from both these ports. We had the most favourable offers from Messrs. Thomas Cook & Son, Bombay, who were able to arrange with the British India Steam Navigation Co. Ltd., Bombay, to accept our cargo on one of their big freighters, the "S. S. OZARDA".

Having reached this stage in our shipping arrangements and having obtained the export license, we undertook to obtain passports both for Baldev Singh, one of our *gwalas* who was also to accompany the animals, and for myself. Complications arose, however, as no passports are issued for Hong Kong without first securing an entry permit from the Immigration Officer there. For political reasons entry to Hong Kong is very restricted. Since we could only get our passports when the entry permits were obtained, we were naturally held up at this point; it took us about three months to get the entry permits and, later, the passports.

Having had earlier correspondence with the Milk Commissioner of Bombay and the Director of the Institute of Agriculture, Anand, on the question of securing the required number of Kankrej animals through them, I made my first trip to Bombay in May 1952 to select the animals and to finalise arrangements for the shipment.

Kankrej cattle were available at the Aarey Milk Colony, Bombay. With the assurances of all possible help from the Milk Commissioner, I was able to select a few individuals of this breed at that colony. In line with our prior arrangement, I then requested Mr. Warner to come down to Bombay for the final selection of the animals and to check on the shipping arrangements. On his arrival we were surprised, however, when the Milk Commissioner, Bombay, gave us the disappointing news that the Ministers of Bombay were unwilling to part with these animals. It was necessary to arrange immediately to obtain the animals from other sources.

Informed of the availability of pure-bred Kankrej animals at two Government Cattle Breeding Farms, at Bakrol and Makarpara, in Baroda, I proceeded there at once. Here again we failed to get the animals. On the day I arrived in Baroda, these cattle farms were transferred to the Go Seva Sangh, under the provisions of a new arrangement with Government!

The best choice of animals, we had felt from the beginning could be made at the Institute of Agriculture, Anand, but as there was an out-break of foot and mouth disease in that herd at the time we initally undertook plans to buy the animals, we had abandoned the idea of getting the animals from that source at that time. Cattle import regulations at Hong Kong require that cattle imported to that port should be free from foot and mouth disease and should be from an area which has been free from foot and mouth out-breaks for at least six months prior to shipping such animals out of that area. The animals are also required to be inoculated against rinderpest and hoemorrhagic septicaemia.

My next move now was to proceed to Anand and try to purchase the animals from the Institute of Agriculture or from their breeding farm at Chharodi. By this time the cattle there were free from foot and mouth which had prevailed at the beginning of our negotiations. With the kind help of Dr. M. D. Patel, the Principal and Director of the Anand Agricultural Institute, I was able to obtain the requisite number of animals, some from Anand and some from Chharodi. Later the animals selected were kept at the Chharodi farm until we could take delivery of them. This did not become possible until about two months later. Leaving arrangements at this, I returned to Allahabad.

The export license issued to us was valid for only three months from the date of its issue. On account of all the delays, the license expired before we could make use of it! It was renewed for three more months without much difficulty, although some delay was involved.

A few days after my return from Ahmedabad and Bombay, I had a chance to go to Calcutta. While there I explored the possibilities of shipping the cattle on an earlier date from that port. The route from Calcutta to Hong Kong is shorter and freight rates much less than through Bombay. For several reasons the Calcutta arrangement did not materialise. We ultimately made use of the services of Messrs Thomas Cook & Sons, Bombay, and shipped from there.

Long before the expected date of the arrival of our boat in Bombay, I went there from Allahabad for the second time. Baldev accompanied me, for he was to take care of the animals until our departure and during our journey to Hong Kong. Arrangements for stabling the animals when they were brought from Chharodi and before being shipped were made with Messrs. Crawford's Veterinary Hospital, located near the Bombay Central Railway Station. This was convenient because the animals were to be unloaded from the train very close to this stable when they arrived from Chharodi.

I found it was impossible to get any definite information on the schedule of any freighter; furthermore, even our shipping agents did not know the complete details of the formalities that one had to observe on this type of a shipment. Each time I visited them, I was required to fulfil some new requirement or formality about which there was no information earlier. This sort of a thing went on till the very last moment. There seemed to be no end to fulfilling new requirements!

From Bombay we proceeded to Chharodi where Baldev was to look after the animals till the time we were in a position to move them to Bombay for shipment. The animals at the Chharodi farm are never tethered or chained in their life, but are let loose in the pastures where they graze the year around. The cows are milked in paddocks in the open. No weaning is practiced on the farm. The animals we purchased had to learn to be tethered so that we could handle them during shipping. It was a difficult job to put the halters on these young strong-built animals. Most of them broke the ropes at once! Leading any of these animals with the help of halters at first proved impossible; they would not move an inch.

Leaving Baldev at Chharodi, I proceeded to Ahmedabad and then to Jaipur. To move these cattle out of the District of Ahmedabad we had

to have the permission of the Collector at Ahmedabad; this I managed to get without any difficulty. We also had to have from the same office a separate permit to take fodder along with the cattle while in transit. This permit was also obtained along with the cattle movement permit.

The importers urged that we have sufficient insurance on each of the animals to cover all risks for the whole journey. Some insurance companies in this country, we learned, would write insurance on many things, including elephants, monkeys and horses, but not cattle! We could finally locate one firm, the Rajasthan Agricultural Livestock and General Insurance Co. of Jaipur, who wrote insurance on cattle also, but they were willing to do so only if we called in person in their office to get the policy written. The coverage we were able to get, however, was not complete. The policy was later cancelled as the importer was able to get more satisfactory coverage with a Hong Kong firm.

The Cattle in the Big City

After finishing the business at Jaipur, I returned to Bombay to check on the sailing date; the plans were to bring the animals from Chharodi to Bombay and I had been warned of the frequent dislocation of the train services on the Bombay-Ahmedabad line because of heavy rains at that season. In view of such possible delays, it seemed advisable to have the animals move to Bombay several days ahead of the date of sailing. Therefore, I again proceeded to Chharodi, this time to book a cattle wagon and load the animals. They were booked by passenger train from Chharodi to Grant Road station, Bombay, via Ahmedabad. When these arrangements were completed, I again returned to Bombay; Baldev accompanied the animals.

The Grant Road Station in Bombay, on the Western Railway, has a siding for unloading cattle only. One can find beautiful specimens of Surati and Murrah buffloes unloaded daily at this siding, consequently a large cattle market exists there. Thousands of rupees worth of business in buying and selling cattle goes on here every day. The Bombay Corporation maintains a veterinary staff here to inoculate all incoming cattle against rinderpest. Our animals, however, had already been inoculated, so this was not repeated.

When the animals arrived safely at the Grant Road Station siding they were unloaded carefully and led to where they were to be stabled until being shipped. One can hire special men, referred to as cattle coolies, at the Grant Road Station siding to handle any number of animals. We hired a few such men to help us walk the animals from the railway siding to the stable. This turned out to be an awful task! The animals had never before experienced such crowded streets and heavy traffic. Fortunately they all reached the stable safely. We had to make our own arrangements for cattle feeds at the stable. Pressed baled hay and other feeds are available in abundance in Bombay, so it was not difficult to care for the cattle. We were required by our shipping agent to take along with us on board the steamer enough cattle feed to last us for at least one month; all we required was purchased and stored in the stable.

About three weeks passed before the "S. S. OZARDA" actually arrived. After it came in I was informed by the shipping agent that the captain was not willing to accept our cargo unless we had with us a 'Humane

Killer'! This instrument is a special type of gun used for destroying cattle and horses with rifle shots. We had no such equipment with us, nor had we made any arrangements for obtaining one. In my earlier correspondence with our shipping agent on this subject I had pointed out to them that it was not absolutely necessary to have a 'Humane Killer', for there were easier and simpler methods of destroying animals when necessary. I could only repeat this when the captain raised this issue. I was able in the end to convince all concerned, including the captain, to accept my statement.

Now again because of the delay of our steamer, the validity of our export license had expired for the second time! By this time, however, the shipping bill for our animals had been made out and, although the license expired before we could actually load the animals, it was not necessary according to our shipping agents, for us to renew it this time.

The "S. S. OZARDA" arrived in Bombay the morning of 24th July, 1952, but she could not be berthed until late in the evening that day because of congestion in the port. Our sailing date was fixed for the 30th of July.

I was informed by our shipping agent on the 29th that I should arrange to take down our animals to the dock to be loaded by 10 : 00 a. m. on the 30th and that the steamer was leaving port at 2 : 00 p. m. that day. Representatives of the shipping agent were present when the cattle were loaded on a cattle truck at the stable, and at the dock. Leading the 12 sturdy young animals on to the truck was extremely difficult. This single operation delayed us very much. Ultimately the animals had practically to be dragged onto the truck. Despite our efforts to get everything done on time, we did not reach the dock with the animals until 11 : 30 a. m.

News about this shipment of cattle had appeared in the leading newspapers of Bombay, so quite a crowd of spectators collected at the stable to watch the loading of the animals. They certainly enjoyed the fun at our cost! There was also a big crowd at the dock to see these cattle taken abroad the "S. S. OZARDA".

Loaded at Last !

We had now very little time left to complete the loading of the animals on the steamer. It was again an extremely difficult task to get the animals up the gangway and on board the steamer. The dragging process was resumed! The captain of the steamer watched this operation until we had loaded just three of the animals. He then came down in a fury and ordered that there should be no more loading of the animals in the way we were having to do it. He further informed me that he was calling the officials of the steamer company to come and give their judgement as to whether we should be allowed to load the animals that way or not. No provision for any loose boxes or cattle slings which could be used for loading the animals had been made by the shipping or port authorities.

The officials summoned by the Captain arrived almost at once, anxious to see what was the trouble. At this time the rest of the cattle walked up the gangway without creating the slightest trouble! The very awkward situation created thus far had been solved and we breathed a big sigh of relief on seeing all our animals on board. A special cattle stall had

been built on the steamer on the open rear deck to house the animals during the journey. Opposite our cattle stall there were eight race horses which were bound from Basra to Colombo.

A photographer, representing the *Times of India* Press, Bombay, appeared to take a few snaps of our cattle, but I am not sure whether he could make any use of his camera. Our steamer left the dock at 2 : 00 p. m.. exactly as scheduled. The cattle were not settled aboard until just about that time.

By late in the evening we were in the midst of the rough Indian Ocean. At intervals big swells flushed the lower decks and the cattle and horse stalls. The steamer rolled and tossed so much that both Baldev and I became sea-sick. Both of us were confined to our beds for practically the whole journey from Bombay to Colombo, which took four days! The steamer crew had to look after the animals up to Colombo.

At Singapore, where we stopped two days, 150 humpless cattle from Bali Island and a dozen albino water buffaloes were taken on our steamer, all consigned to Hong Kong for slaughter purposes. We arrived at Hong Kong in the evening of the 21st of August, 22 days out of Bombay.

At Hong Kong our cattle were to be transhipped to Taiwan (Formosa). Representatives from Taiwan met us at Hong Kong to take charge of the animals on the 22nd morning. Our steamer anchored in mid-steam; with the help of special crates the cattle were unloaded to a tender and taken ashore to the quarantine station. The next day they were taken aboard another steamer bound for Taiwan. It sailed on the 24th of August.

After giving over charge of the cattle to the Taiwan people I was free of my responsibilities and had about four days in which to see Hong Kong.

This city is on a small island; it is a free port. Kowloon Bay separates Hong Kong from the mainland of China. Kowloon is another city across the bay on the mainland, under the same administration as Hong Kong. Hong Kong depends for practically all her food-stuffs entirely on imports. Fishing is one of the main industries in this area. These cities import all the red meat they require from Australia; large quantities of frozen evaporated milk are imported from New Zealand.

A privately managed Dairy and Cold Storage organisation meets all the requirements for meat and milk for the island as well as for Kowloon; most of these products are imported from outside. The evaporated milk is reconstituted and sold along with a very small quantity of fresh milk produced by the herd which is owned by the Dairy. This organisation also supplies all the ice required by the fishing industry of the area.

Being a free port, Hong Kong offers all sorts of imported articles, other than food, at prices which are so low that they are almost beyond the imagination of one from India.

Our return trip was by air. Passage was booked on a B. O. A. C. 'Argonant' plane on the Tokyo-London route. We took off from Kowloon in the early morning of the 26th of August and landed at Calcutta the same

afternoon at 3 : 30 p. m., having stopped at Bangkok and at Rangoon. The flight was very smooth and most enjoyable throughout. The whole route was covered within 10 flying hours.

We reached Allahabad on the 27th morning, making the trip from Calcutta by train. By the time we arrived at Allahabad news that the cattle had reached their destiny in Taiwan safe and sound had already arrived.

LOWERING COST OF CULTIVATION IN BERSEEM

By

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INTRODUCTION :

Berseem or Egyptian clover needs no introduction to modern dairy farmers in India. Under favourable conditions it starts growth with remarkable vigour in winter, makes quick recovery after defoliation and produces palatable, nutritious green forage. In spite of its superiority from the point of view of animal nutrition, it is not gaining the popularity that it deserves owing to its high cost of cultivation. Two items of expenditure which contribute most towards its cost of production are harvesting and irrigation charges. Normally 5 to 6 cuttings are taken during the season yielding 500 – 600 maunds of green fodder per acre and after every cut the crop has to be irrigated to ensure quick recovery.

LAYOUT :

A study was initiated this year at the College farm to compare costs of harvesting with a bullock drawn mower in a border strip method of layout (vide chart) with the traditional method of harvesting with sickles in small check irrigation beds (*kiaris*). So far the practice has been to divide the berseem into small checks (*kiaris*) of varied dimensions depending on the source of irrigation. This type of layout renders the field unsuitable for harvesting with a mower.

For the purpose of study the layout of the field was modified to adapt it for harvesting with a McCormick bullock–drawn mower with a four-foot cut. The field was 3.5 acres stretching east to west, rectangular in shape with the main *pucca* irrigation channel from the tube-well bordering the north side. The land was graded very carefully at the time of preparation of the seedbed so that there was a gradual slope from centre to east and west. Two strips 14 ft. wide at the east and west ends of the field which were also sown with berseem, served as headland for turning the bullocks along with the implements. Then the rest of the field was divided length-wise into 14ft. strips separated by low ridges alternating with secondary 2 ft. wide, irrigation channels, as shown in the sketch. The breadth of the strip was kept 14 ft. to enable the mower to cover the width in 3 turns. Water was supplied to the secondary channels and strips from one 3 ft. broad shallow supply channel running about the centre of the field north to south across the strips. It was higher than the level of the rest of the field but shallow enough not to hamper the progress of the mower during harvest.

SOWING :

The seeds were broadcast on the strips at the usual seed rate of 20 lbs. to the acre (without irrigating the land). The seeds were mixed with the soil with a peg-tooth harrow and then the strips were irrigated lightly. With the help of a wooden plank equal to the breadth of the strip, the entire length was irrigated in parts. The plank served as a temporary

ridge to control water and to avoid loss of seed with flowing water. The part farthest from the median irrigation channel was first irrigated, then the next parcel and subsequently the nearest. This measure ensured an even distribution of the water. Sowing by this method resulted in normal germination. In subsequent irrigations the plank was used frequently to control distribution along the strips from the secondary water channels. On the ridges and the sides of the irrigation channels, radishes were sown to utilise the spaces where berseem was not growing.

COMPARATIVE COST IN THE LAYOUT OF SEED BED AND SOWING FOR 3.5 ACRES :

	Border strip method of layout		*Small check bed layout*
1.	Cost of layout ...	Rs. 33 8 0	Rs. 42 0 0
2.	Cost of sowing and irrigation ...	9 0 0	10 8 0
		42 8 0	52 8 0
	Per acre cost ...	Rs. 12 2 0	Rs. 15 0 0

HARVESTING :

In a day of 8 working hours it was seen that the mower could harvest three acres and two labourers were needed to mow and collect the harvested forage. The price of the mower was Rs. 800. On an average it was kept engaged in harvesting both *kharif* and *rabi* forages for 120 days in a year. Hence the cost of harvesting 3 acres per day worked out as follows :

1.	Depreciation at 10 p. c.	0 10 8
2.	Interest on capital at 2 1/2 p. c.	0 2 8
3.	Repair charges at 4 p. c.	0 4 3
4.	Cost of one pair of bullocks	3 0 0
5.	Wages of mower driver at rate of Rs. 2/- and one labourer at rate Re. 1/-	3 0 0
		7 1 7

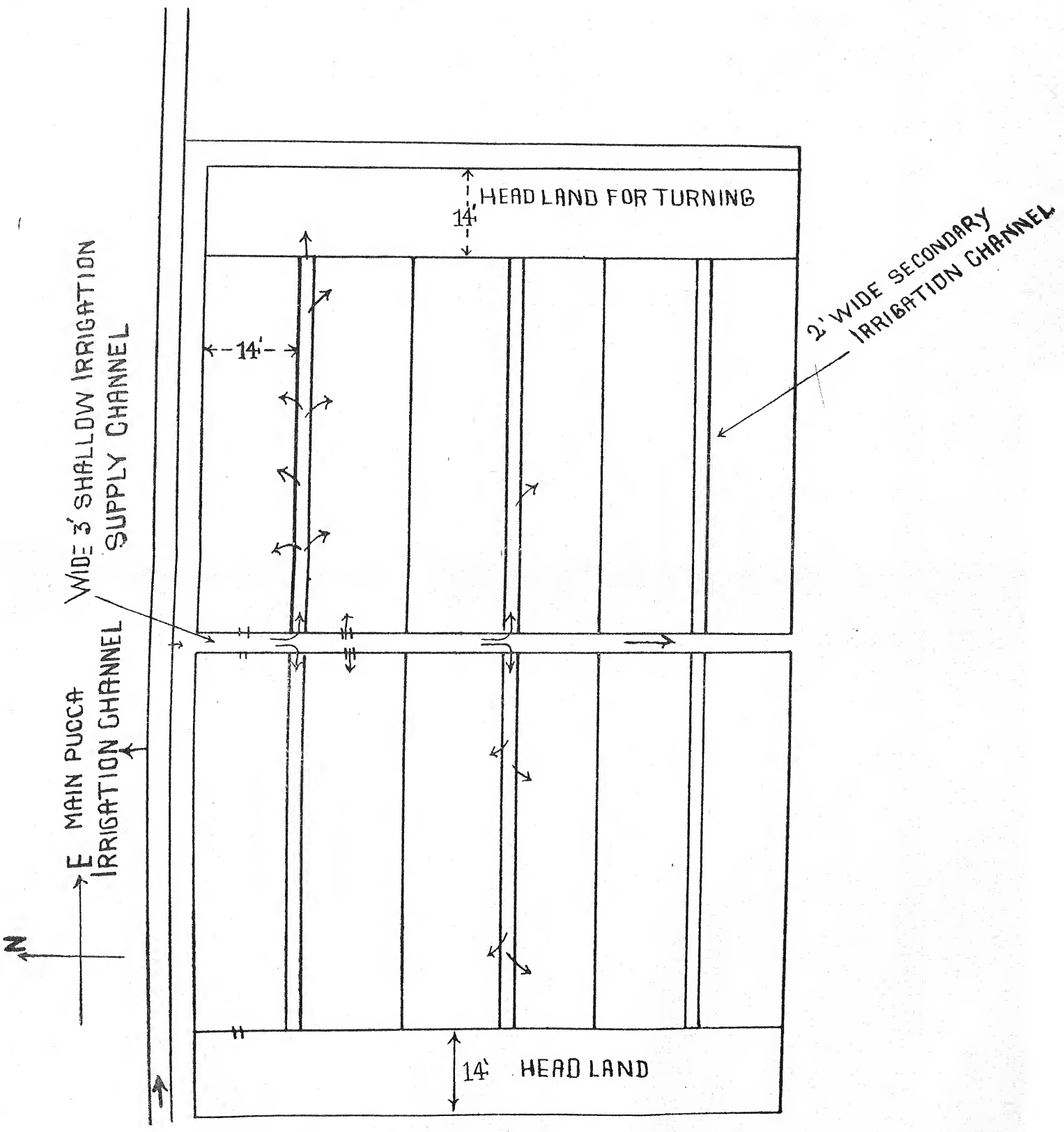
Hence cost of harvesting one acre comes to Rs. 2/5/10. Whereas with sickles it requires 12 labourers per acre at rate 1/- *i. e.*, Rs. 12/- per acre.

IRRIGATION :

It was observed that with this method of application of water in strips a saving of about 15-20 per cent in labour and water was achieved. Thus with a total of 5 irrigations in all, the cost of one application, Rs. 15 can be saved.

SUMMARY :

From the above observations it is apparent that the difference in the cost of layout and sowing between the two methods is not very wide. But the cost of harvesting is much lowered with the mower resulting in a net saving of almost Rs. 10 per cut which would work out to Rs. 70-80 per acre per season including saving in irrigation charges. Moreover, an intelligent farmer owning a mower will use it to harvest other mature crops as well by changing the sickle blade, thus reducing its fixed cost in figuring the operating expenses of harvesting.



BORDER STRIP METHOD OF LAYOUT

HOW TO GROW MORE PADDY

By

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This article deals with practices of cultivation which have proved definitely superior over methods commonly practised by cultivators. By improving soil tilth, nurseries, manuring, and supplying adequate water during the growth of the plants, we can considerably increase the yield of this crop. It can be claimed without doubt that no other crop responds more to these essentials of crop production than paddy. In order to meet the growing demand for food in the country, we should not ignore such measures to increase the yield of the already cultivated fields.

SOIL TILTH :

Repeated ploughings during summer, after harvesting wheat or any other *rabi* crop, until the next sowing of the paddy seed has a marked effect on good germination of the seed, growth of the seedlings and finally upon the crop yield. A deep ploughing with an iron plough followed by five to six ploughings with a *desi* plough all at about an internal of a week are sufficient for the preparation of the field. Just prior to sowing, the fields should be ganned once and thereafter the seeds sown.

The data given below represent the yield per acre obtained by following the practice as suggested above.

TABLE NO. 1

Table of yield per acre in Lbs.

Treatments :	1950-51
(1) Three ploughings in summer, puddling and ganning	1186.3 lbs per acre
(2) One deep ploughing with an iron plough followed by six *desi* ploughings in summer, ganning	... 1305.9 ,, ,, ,,
(3) No ploughing; ganning in summer	... 1102.6 ,, ,, ,,
(4) Ploughing in water, no ganning	... 1283.2 ,, ,, ,,

BROADCAST VERSUS TRANSPLANTED :

So far as yield is concerned, not every variety responds equally to broadcasting and transplanting. It largely depends upon the inherent quality of the variety itself, the soil and climatic conditions of the locality and other factors as irrigation and labour facilities. Where labour may not be easily available, it is convenient to take up broadcasting as transplanting involves double work, firstly in nursery sowing and thereafter in transplanting. It has been proved that transplanting yields better than broadcasting, particularly because we cannot be sure of 100% of germination in the latter whereas there is very little chance for the transplanted seedlings to die, provided adequate irrigation facilities are available.

TABLE NO. 2

Yield in Lbs. per acre, 1945-46

Name of Variety	*Broadcast*	*Transplant*
H. 287/1	1027.2	1645.7
H. 400/1	648.8	1238.1
H. 404/1	503.3	884.3
H. 332/1	505.0	1148.9
H. 162/1	931.3	1199.6
H. 251/3	563.2	1364.2
H. 278/1	672.8	1391.9
H. 317/3	453.7	1330.3
H. 64/3	1198.4	2017.8
H. 262/2	1153.5	1934.4
H. 42/4	842.3	1293.4
H. 64/2	1316.5	1494.9
H. 78/1	873.1	1604.1
H. 393/1	517.0	1561.6
T. 136	1081.9	2160.8
N. 22	701.9	1545.6

NURSERY SOWING :

Where there are no facilities for irrigation, seed should be sown in the nurseries at the break of the monsoon, though the latter being sometimes uncertain, has a direct bearing on the yield of the crop. But if water is available, we should not wait for nursery sowing till the break of the monsoon.

The land where nurseries are to be sown should be ploughed well during the month of April or at the latest by the beginning of May as to reduce the soil to a fine tilth and level. This land should then be divided into nursery beds of sizes which may vary according to the level of the plot. They may generally be 16 x 12 ft. or 10 x 12 ft. If the fields are very well levelled the size may even be bigger, perhaps 20 x 24 ft. Irrigation channels should so alternate with rows of nursery beds that one channel may irrigate beds on both sides.

Nursery beds should be well manured long before with well-rotted farmyard manure or compost at the rate of 200 to 250 maunds per acre or by the application of finely powdered castor cake at the rate of 15 to 20 mds. per acre. But best results are obtained by applying ammonium sulphate at a rate of 4 to 5 mds. per acre at a time when the plants attain a height of about 4 to 5 inches. Plants respond to ammonium sulphate or any other inorganic nitrogenous fertilizer more readily than to organic manures, the latter being available to the plants much later or sometimes are not at all available to the plants because their disintegration into simpler chemical plant foods takes a long time.

There are different methods of sowing seeds in a nursery, varying locally. Seed may be sown dry in a dry nursery, or sprouted in a wet and puddled nursery though best results have been obtained by the latter method, it having several advantages over the former one. The foremost advantage is that in a puddled field there remains little chance for residual

weed seeds to germinate as during puddling a larger percentage of these go deep down into the soil and there they decay. Secondly the radicles of the germinated seeds of paddy find an easier enterance in the puddled soil than a dry soil which has been irrigated afterwards.

Dry seeds, in dry nursery beds just immediately after their sowing, are covered with farmyard manure, cowdung or sawdust.

Time of sowing and transplanting has a direct bearing on the yield of this crop. It can be said as a rule that the earlier the sowing and transplanting the better would be the yield. It has been observed that nursery sowing as early as the first week of May and subsequent transplanting in the first week of June gives the best results which is due to the fact that plants get a longer period for their growth and development.

SEED RATE

This largely depends upon the fertility of the soil, the individuality of the variety, and local conditions of the tract. Where the soils are highly fertile, seedlings raised from 6-10 srs. of seed are enough to cover an acre of the field when transplanted. Fine paddies require less seed than is required by coarse ones. Where a larger number of seedlings, say more than 2 or 3 are transplanted into a single hole, the seed rate increases in proportion to the number of seedlings transplanted. A number of seedlings per hole are generally transplanted in a field of low fertility, because in such soils seedlings tiller very little if at all.

It has been observed through experiment that even in very fertile soils a larger number of seedlings per hole give larger yields, though not in proportion to the number of seedlings transplanted per hole. As an emergency measure to combat the present food crisis in the country, it can be suggested that 3 to 4 seedlings be transplanted per hole in fertile soils and even more in soils of low fertility.

Generally 1/10 to 1/20 of an acre under nursery is sufficient to transplant an acre, varying according to the number of seedlings to be transplanted per hole.

For single, 3-4, and 6-8 seedlings per hole we may use 5 srs., 10-12 srs. and 20-25 srs. of seed per acre respectively. Nurseries should preferably be dense so as to avoid tillering before transplanting.

Generally 20-30 srs. of seed per acre is used in broadcasting, depending upon the variety itself and the germination percentage of the seed.

Nurseries are profusely irrigated, and thoroughly weeded at regular intervals after the seedlings are about 20 days old. Transplanting after 4 or 5 weeks gives the best yields. Seedlings may be uprooted from the nursery taking care to avoid damage to the roots and then should be planted in well puddled fields at spacings of about 6 to 8 inches.

IRRIGATION

Paddy flourishes best under hot and moist climate. Though certain varieties to some extent are resistant to drought, most varieties require much water for their successful growth. Transplanted seedlings

can withstand greater submergence in water than those from broadcast seeds. Transplanting can therefore be well suggested for submerged areas.

It has also been recorded that in addition to natural rainfall, increasing doses of water given at regular and short intervals, say 6 inches irrigations at an interval of 4 days result in increased yield in comparison to 2 and 4 inches irrigations at intervals of 8 to 12 days. The data given below supports this statement :

Quantity of Water	*Yield in Pounds per acre*			
	Intervals			
	4 days	*8 days*	*12 days*	*Mean*
0"	2302.5	...	...	2302.5
2"	2612.3	2290.8	2191.5	2364.9
4"	2816.8	2273.3	2483.7	2524.6
6"	3003.8	2740.8	2174.0	2639.5

It can therefore be suggested that higher doses of water given to this crop prove very beneficial in obtaining higher yields.

MANURING :

It has been observed that paddy responds more to manuring than any other cereal. Higher doses of manures give increasing yields as high as two to three times. Both organic and inorganic manures used singly or in combination have a significant effect on the growth, development and yield of the crop. Green manuring with *sanai* or *dhaincha* has been found to yield best results in comparison to other manures. Next to green manuring, Nicifos (an inorganic fertilizer) has been found to fare best. These results have been calculated on the basis of extra yield obtained per lb. of N2 applied, and the data given below support this statement.

	Extra Yield per lb. N2 applied (*In lbs.*)
1. *Ammonium Sulphate*	
30 lbs. Nitrogen per acre	11.4
50 " " " "	8.6
60 " " " "	11.4
2. *Nicifos II*	
25 lbs. Nitrogen per acre	16.6
50 " " " "	13.0
3. *Oil cakes* (*groundnut, nim or castor*)	
20 lbs. Nitrogen per acre	8.9
40 " " " "	7.2
60 " " " "	6.0
4. *Farm Yard Manure*	
25 lbs. Nitrogen per acre	6.0
50 " " " "	6.7
5. *Green Manuring with Sanai*	
50 lbs. Nitrogen per acre approximately	21.0

6. *Town Compost*

50 lbs. Nitrogen per acre	5.8
100 ,, ,, ,, ,,	5.0
150 ,, ,, ,, ,,	4.0

7. *Mixed Manuring (Nicifos II plus farm yard manure).*

25 lbs. Nitrogen per acre	12.5
50 ,, ,, ,, ,,	11.0

The data given above give an idea that almost all organic and inorganic nitrogenous manures promote heavy yields in paddy. In a treatment where mixed manuring of Nicifos and farmyard manure has been used, yields were appreciably increased and it is possibly due to the fact that each lb. of Nicifos nitrogen gives more extra yield than any other manure save green manuring; and this high 11 to 12.5 lbs. of increas per lb. of nitrogen applied is not due to farmyard manure as the later when applied singly has yielded only 6.0 to 7.0 lbs. extra, per lb. of nitrogen applied

Green manuring should therefore be considered to be the best for paddy, firstly because each lb. of nitrogen applied through green manuring gives more extra yield of the crop than any other manure and secondly being an organic manure, it enriches the soil more in plant foods than inorganic fertilizers in the sense that the nitrogen of the inorganic fertilizers, being readily available is taken up by the plants immediately thereby leaving no residual plant food. But in the case of green manuring like other organic manures, some plant foods are left behind after the harvest of the crop, even when they are being more utilized. Thirdly, green manuring is cheaper and more economical than other manures.

But the greatest handicap in green manuring is the non-availability of sufficient rain water during the months of April and May, when the seeds of *sanai* or *dhaincha* should be sown for the purpose. It is very useful if a ready source of water supply be at hand. Though not much water is needed to grow *sanai* or *dhaincha*, yet some water at regular intervals must be available for proper germination of the seed and the growth of the plants. It can be suggested without doubt that if arrangements be at hand for timely irrigating the fields, green manuring should be a "must be" practice for paddy.

Use of Improved Seed :

It is really unfortunate that the cultivators still sow seeds of the indigenous local strains, which are generally far lower yielding than the improved seed distributed by the agricultural departments of the different states. This improved seed is obtained at the research stations by proper selection of the local strains or by hybridization of different strains possessing varying desireable characters.

Cultivators may therefore contact for their seed requirement, the District Agricultural Officers of their respective districts, who would arrange the supply through their seed stores. District Agricultural Officers will also advise as to the type of seed which would be higher yielding and more economical for the particular tract of the cultivator.

SUITABLE CROP ROTATIONS :

For improved cultivation it is essential that the soil fertility should always be maintained otherwise even the best soils becoming devoid of fertility through continuous cropping would prove very harmful to the subsequent crops. For this not only should we adequately manure the fields, but at the same time plant suitable crops in rotation with paddy. If plenty of water is available, berseem has been found to be an excellent fodder crop after paddy, as it has been observed that it enriches the soil to the extent that it almost becomes black in colour, which is an indication that a large amount of humus (vegetable matter) has accumulated in the soil.

Rotations vary much according to the local practice depending more upon the facilities for water and secondly upon the weather conditions. Pea and gram have also been considered good rotations, depending much upon the factors mentioned above. Pea cannot be taken with success, where frosts occur very frequently. Gram can conveniently be taken where irrigation facilities are not regular and frost does not damage this crop often. Both pea and gram, being legumes fix nitrogen in the soil.

Planned experiments are under way to determine if *juwar*, sugarcane or cotton proves to be better or equally good economical rotations with paddy.

INTERCULTURAL OPERATIONS :

It is excellent to plough frequently the standing broadcasted paddy crop, as it not only promotes better tillering in plants and finally a high yield, but at the same time it also uproots most of the existing weeds in the fields. Weeding is another important operation. Fields must be thoroughly weeded before the weeds attain an appreciable height. It has been observed that during periods of drought and abnormal weather conditions weeds flourish better than under normal conditions only because they are hardy in comparison to paddy seedlings which require mud-water for their favourable growth.

DOUBLE CROPPING OF PADDY :

Where enough water, when needed,is available, two crops of paddy in one year can easily be taken.

A crop sown or transplanted in the middle or end of April, may be harvested by the end of July. By the time of harvesting, a nursery must be ready for transplanting the second crop, soon after the harvest. Three or four ploughings should be given to the field and the second crop should be transplanted by the beginning of the second week of August.

It has been observed that the commulative yield of two paddy crops is always higher than a single crop of paddy taken on the same field and under similar conditions of growth.

During 1951-52 the total area under cereals and pulses in the Indian Union was 23,45,58,000 acres, of which Uttar Pradesh accounted for 4,41,46,000 acres and Bombay came next with 2,70,80,000 acres.

CHEMICAL MAGIC IS HERE

By

F. H. SHUMAN

Formerly of the University of Illinois Agricultural Extension Staff and now with the Extension Service of the Allahabad Agricultural Institute.

Ammonium sulphate or chemical nitrogen is one of the newest players on the Agricultural production stage. However, this new force must be used judiciously and intelligently.

Agronomists and soil chemists in India recognize that after 2000 years or more of crop removal, the soil fertility bank is almost empty of nitrogen. Deposits of other essential elements, in many instances, are below the danger line. Withdrawals, they say, have been continuous while deposits have been negligible.

Low yields and the hunger signs of the crops themselves stand as silent evidence that life-giving elements which make for high production must be replenished.

In the final crop of any soil is people, then it is imperative that ways be designed to make Indian soils continuously productive at a high level of fertility.

Chemical nitrogen has great potential possibilities. It is the most acclaimed player on the agricultural production stage today in America and in parts of India.

This new player however, is as supersensitive as the leading actress on the cinema stage who declines to act unless she can choose the other characters who will perform with her.

In fact "Miss Chemical Nitrogen" will not perform unless "Mr. Phosphate" and "Mr. Potash" never leave the stage. They must continually flatter her with their presence. When "Mr. Phosphate" signals his presence, she has personality plus. However, she really is at her best if "Mr. Potash" is especially attentive. Let "Mr. Potash" leave the stage, her acting becomes dull and monotonous ; she throws a fit and sulks to the utter disgust of the manager who has paid the bill for her performance.

In a similar manner "Mr. Potash" refuses to perform with gusto and animation unless "Miss Nitrogen " is present.

Balanced soil fertility means that the three legs of the stool, namely nitrogen, phosphorus and potash shall be of equal length. This rule holds true whether the legs be long or short or whether the soil is at the high fertility level or the low fertility level.

In Illinois, trials with chemical nitrogen gave an increase of only 1 1/2 maunds of maize per acre in a field where the soil was deficient in both nitrogen and potash. A liberal application of potash gave an increase of only 1 1/2 maunds of maize on the same field, lacking in both nitrogen and potash.

But presto chango ! Where both chemical nitrogen and potash were put on together, the increase was 27 maunds of maize.

Then the question arises "Can chemical nitrogen be used as a substitute for manure or compost ? No and three times no, is the right answer. Chemical nitrogen should be used to *supplement* composting and the nitrogen supplied to the soil by heavy tonnages of legumes.

The value of manure-composting has been demonstrated in village India. In Nagwan village near Patna, the saving of all refuse and returning it to the soil by the compost method, resulted in a 32% increase in crops. This is a tremendous increase. Composting should have the support of every thinking person interested in the rural uplift of India.

However, composting alone will not result in a long-time soil building program as only part of the bank withdrawals are returned to the soil. Feeding the crops to cattle results in approximately a 25% loss of nitrogen and at least a 10% decrease in the phosphorus and potash returned.

In addition, crops grown on soils which are deficient in essential minerals, contain less of these minerals than when the roots are feeding in an abundant supply.

A test made in Illinois showed that maize grown on a soil testing only 75 lbs. of available potash per acre contained only one half as much potash as maize grown on a soil *not* deficient in potash (200 lbs. or more). When the potash-deficient maize was fed to cattle then the manure only contained one half as much potash as it should have contained.

When the potash content of a soil becomes low you can't raise it up again except by applying the mineral itself to the deficient area. As the saying goes, you can't pull yourself up by your own bootstraps. A compost-manure program has tremendous merit. But it will not by itself change Indian agriculture to a "soil building" program.

Legumes Important

Chemical nitrogen is not a substitute for the nitrogen restored by legumes. Deep roots that increase the feeding area of the crops that follow, the increase of water holding capacity, the added tilth, the stepped-up bacterial life – all these are a credit to the legume side of the soil fertility ledger.

A new tool

Chemical nitrogen is a new tool. Like all new tools it will take time to learn to use it economically and intelligently.

If the soil-building bank account is to be filled, then *all three* methods of making deposits must be adopted. Repeating, we mean composting, the growing of luxuriant legume crops, and then using chemical nitrogen judiciously on non-legume crops, when responses are certain to be forthcoming.

The Indian Government has a supply of ammonium sulphate (20 % nitrogen) which is being manufactured at Sindri. The cost to villagers

would be approximately Rs. 20 per 100 lbs. of ammonium sulphate containing 20% of the actual element nitrogen. When other elements are not lacking, chemical nitrogen will give an economical response on a nitrogen-starved soil.

It takes 2 1/2 lbs. of chemical nitrogen to make one maund of oats ; about 3 lbs. to make a maund of wheat and 2 1/3 lbs. of nitrogen to make 1 maund of maize in the ear.

Soil Minerals important

If phosphorus, potassium, magnesium, manganese, or boron is in short supply, then the compost-manure which is made from the crops grown on a mineral-deficient soil will also be in short supply.

Legumes to grow luxuriantly must have an abundance of minerals for their roots to feed on.

Chemical nitrogen only puts on a first class show when the so-called "basic minerals" are continually on stage.

Laboratory is a tool

Fortunately, the available phosphorus and potash can be measured in pounds per acre. The soil laboratory combined with tissue tests and field experiments is the only way now known to tell whether these two great actors are performing half-heartedly because of near exhaustion or depletion.

When crops are so hungry that visible signs are in evidence, the farmer may be 15 years or even centuries late in supplying the elements which prevent malnutrition. Years of progress could be made with the soil laboratory as a tool or guide. Trial and error will work but this is time-consuming and, therefore, costly. The penalty for low yields has already been paid.

At today's prices, needed nitrogen, phosphate, and potash fertilizers are not costly. The real cost is in doing without them. Making a mineral inventory by a soil laboratory method will determine the economic use of basic minerals in the soil fertility "build-up" program which India sorely needs.

What the soil does not have, plants will not get and animals and man will lack also. Starvation symptoms usually appear long after hunger actually occurs.

Village India can not afford to wait much longer ! In numerous villages there is sufficient leadership developed by the Extension Services that research findings in soils would find ready acceptance.

Yes, the final crop of any soil is people, and the spirit of the people is tied both directly and indirectly to the soil fertility level of village India.

AGRICULTURAL HOLDINGS IN U. P.

By

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A clear knowledge of the distribution of agricultural holdings into different size-groups, on a regional basis, is of prime importance for the proper appreciation of the land problems and for formulating a sound land policy. But unfortunately such information, to a very large extent, is non-existent not only in U. P. but in many other states of the Indian Union, although many of them have adopted far-reaching measures of land reform. In fact, the study of agricultural holdings has received inadequate attention and has lacked expert handling.

In estimating the average size of holdings, very often the distinction between the agriculturists and many small-holders who follow agriculture only as a subsidiary occupation, e.g. agricultural labourers, village servants, and artisans, has not been fully appreciated. In consequence, the estimate of the average size of agricultural holding is often much reduced.

In one case where the average number of persons per agriculturist's family was assumed to be the same as for the while population i.e. 4.8, the number of cultivating families and therefrom the average size of holding was worked out. This assumption that the size of the family of agriculturists is the same as that of other groups of the poupulation is not quite correct. Our investigations show that the size of the family of agriculturists is larger than that of families in other groups. This finding of ours is supported also by the preliminary investigations into agricultural labour conditions recently conducted by the Central Government in various states and also by independent private rural surveys. Therefore, to calculate the number of agriculturists' families on the basis of the average size of family for the total population and to deduce from it the average size of holding would mean understimating it.

Some of the workers have mistaken *khata* for agricultural holdings, while some other have confused the number of holdings with the number of persons as recorded in part I of the Khatauni (the register in which a record of persons cultivating or otherwise occupying land is made). Our study of nineteen villages in Kanpur district showed that the number of persons as recorded in part I of the Khatauni was 2,037 while their families and so their holdings numbered only 987. The total number of holdings, inclusive of sub-tenants recorded in Part II of the Khatauni and also the un- recorded *batai* tenants (share croppers) whose holdings were found out by actual investigations, was 1,135.

SIZE OF HOLDINGS

An investigation into the size of holdings in four districts covering 147 villages, selected on a random basis after dividing each district into agriculturally homogeneous regions, was conducted by us during 1946-50.

Single village studies have been made in several other districts of U. P. and the results obtained agree fairly closely with the results obtained in the four districts. The percentage distribution of the cultivating families or holdings in different size-groups of holdings in three of the district is given in table no. I. The figures in columns 'B' show the percentage distribution of holdings when those below 1 acre have been excluded.

Table No. I

Percentage Distribution of Holdings

Class interval	Meerut		Bulandshahr		Ghazipur	
	A	B	A	B	A	B
Below 1 acre ...	23.9	...	25.9	...	41.5	...
1—2.5 „ ...	19.3	25.3	12.7	17.1	27.6	47.2
2.5—5 „ ...	18.5	24.2	18.2	24.6	18.3	31.3
5—7.5 „ ...	12.2	15.9	14.1	19.0	5.6	9.6
7-5—10 „ ...	8.1	10,6	9.2	12.4	3.0	5.1
10—15 „ ...	7.2	9.6	10.3	13.9	2.4	4.1
15—20 „ ...	3.9	5.2	4.0	5.4	...	...
Above 20 „ ...	6.9	9.2	5.4	7.6	1.6	2.7
Average size of holdings in acres .	6.5	8.47	5.8	8.96	2.7	4.27

In the case of Kanpur district 37.8 percent holdings were below 1 acre, 20.9 percent between 1 and 2, 17.5 percent between 2 and 4, 16 percent between 4 and 8 and 7.8 percent above 8 acres. On excluding those below 1 acre the percentage distribution of holdings was 29.9 between 1 and 2 acres, 28.7 between 2 and 4, 26.6 between 4 and 8 and 14.4 above 8 acres.

It will be seen that the average area of land per holding declines as we proceed from west to east U. P. It varies from 6.5 acres in Meerut, 5.8 acres in Bulandshahr, 2.96 acres in Kanpur to 2.7 acres in Ghazipur, when all the cultivating families whether following agriculture as a principal or subsidiary occupation are taken into account. Although a number of the cultivating families with holdings between 1 and 2 acres follow agriculture as a subsidiary occupation, particularly in West U. P., even if cultivating families with holdings below 1 acre who depend for their livelihood mainly on labour, village service, cottage work, etc. are left out, the average area per holding is increased to 8.47, 8.96, 4.43 and 4.27 acres in Meerut, Bulandshahr, Kanpur and Ghazipur districts respectively.

DISTRIBUTION OF CULTIVATED AREA:

The following table shows the percentage distribution of total cultivated area in different size-groups of holdings in one western and one eastern district :

Table No. II

Class of interval	Bulandshahr	Ghazipur
Below 1 acre ...	1·4	7.8
1 to 2.5 acre ...	3.2	18.6
2.5 to 5 acres ...	9.8	23.0
5 to 7.5 acres ...	13.6	11.1
7.5 to 10 acres ...	12.4	11.7
10 to 12.5 acres ...	9·9	5·4
12.5 to 15 acres ...	8.9	1.6
15 to 20 acres ...	10.6	4.1
Above 20 acres ...	30.2	16.7

CONCLUSIONS :

The results obtained from this pilot survey are very revealing. The situation with regard to size of agricultural holdings in the case of cultivating families following agriculture as principal occupation is not so unsatisfactory as has been made out by many of the writers on this topic. The figures in Table 1 show that among the cultivating families following agriculture as their principal occupation more than 50 percent have holdings above 5 acres in the western districts. Even in Ghazipur, a district in East U. P., more than 21% of the families possess holdings above 5·acres. Holdings above 4 acres in Kanpur form 41 percent of the total.

The situation in regard to the distribution of the total cultivated area in different size-groups of farming units is still better. The figures in Table II and single village studies in several other districts show that only about 4 to 6 percent of the total cultivated area in the western districts of U. P., 8.7 percent in Kanpur and 26 percent in Ghazipur district are cultivated in holdings of less than 2 or 2.5 acres. Even in the districts of eastern U. P., the farming unit for more than 40 percent of the cultivated area is more than 5 acres. In Kanpur 58.5 percent of the total cultivated area is cultivated in more than 4-acre holdings. In western districts about 80 percent of the land is cultivated in more than 5-acre holdings. These facts should go a long way in correcting the commonly held belief that most of our land is cultivated in very tiny holdings. In fact, so far, the difference between the percentage distribution of cultivating families and that of cultivated land in different size-groups of holdings has lacked the necessary emphasis, although it has a great bearing on the issue of individual versus joint farming. The information about the percentage distribution of the cultivated area in different size groups of holdings in the different tracts of U. P. should prove of invaluable help in coming to a right decision in regard to the future place of small-holders and those with holdings above 5 acres *vis-a-vis* joint farming, and also in determining the areas in the U. P. which should have priority for the development of co-operative farming.

Therefore, to conclude, the study of agricultural holdings in U. P. either by the census-method, i.e. through complete enumeration, or on the basis of random sampling is most urgent, especially on the eve of far-reaching land reform and agricultural planning. No financial or organisational difficulties of any appreciable magnitude are involved in undertaking such an investigation. The necessary information can quite easily be secured from the village records in collaboration with the village panchayats. In view of the great variation in the percentage distribution of holdings in different size-groups in the different tracts of U. P., it may be stressed that the investigation should be on regional basis. An overall average for the whole of the State is as unreal as the average in the proverbial story of the mathematician crossing the river.

* * *

There has been more progress in farming in the last 75 years than all the world's farmers had been able to achieve in the previous 75 centuries. In a recent article in Life Magazine, 'Farm Revolution – More Food for Less Work', this result is ascribed to the agricultural revolution which began about 75 years ago when the agricultural departments of certain western countries began to search for ways to improve the production and quality of food. Later, as good land became scarce, private industry joined in the search.

The United States government has spent, since 1900, about one billion dollars (Rs. 4,75,00,00,000) on agricultural research. Yet now each year one single development, hybrid maize, brings in to American farmers enough extra national wealth to pay for the entire federal government program for the past 52 years ! Fundamental research often pays very big dividends in increased prosperity.

The agricultural revolution is many sided – new machinery and implements, new livestock, crop rotations, plant breeding, fertilizers, irrigation, insecticides. Each is important and correlated with the others.

There are those who predict that the accomplishments of the next 25 years will dwarf those of the previous 75.—A. P. B.

THE RICE BUG

(Damage, Life History and Control)

By

P. K. Biswas, B. Sc. (Ag.)

Never in the agricultural history of our country has the rice bug received so much attention as during the *kharif* (rainy) season of 1952. Large-scale infestation on several million acres and the consequent loss of a considerable amount of paddy were reported from various states like Bihar, Madhya Pradesh, Uttar Pradesh, and Orissa.

Two species of rice bug have been noticed in our country, viz., *Leptocorisa varicornis* Fabr. and *L. acuta* Thumb. But in North and in N. E. India *L. varicornis* Fabr. alone is reported to damage paddy, though in the course of observations at Kanpur, the other species has also been noticed. They are more or less alike, though *L. acuta* is more robust and yellowish. According to Aiyer, it causes considerable damage in South India. The home of these insects has not yet been conclusively determined, but they are found in both North and South-East Asia and are considered to be oriental pests. *Leptocorisa* species are commonly known in our country as *gandhi* bugs due to the pungent and unpleasant smell they emit. They belong to the family Coreidae of the order Hemiptera.

Damage :

These insects are voracious eaters, and the damage is caused by both nymphs and adults. They suck the milky juice of the paddy so that nothing but the chaff remains. Normally the loss is about 10 per cent but heavy loss has also been noticed. This year in one farm near Purulia the loss caused by this pest on early Ch. 10 paddy is estimated to be about 80 per cent. According to Pant losses up to 97.3 per cent have also been noticed.

Uichanco says that this pest not only eats away the paddy grains but 'the damage is also due to certain other factors like enzymes which probably are introduced in the plant cell during the process of suction'. But this view has been criticized by many.

Food Plants :

Though this is a serious pest of paddy, it has also been found to attack the millets, maize, *jowar*, *bajra* and sugarcane.

Life history :

Adults of *Leptocorisa varicornis* Fabr. are pale greenish, slender insects of about 14.3 to 14.7 mm (about $\frac{3}{4}$ inch) in length. From the adjoining grasses it comes to the paddy fields and the period of activity is from the middle of August to the first week of November. Temperature controls its activities. It meets a natural death with a couple of good showers in October or with a fall of temperature and the surviving ones migrate to the surrounding areas in the grasses and weeds and also in the jungles to continue their life cycle at a slower rate.

It is adiurnal pest and the insects copulate more generally in the morning or in the day but rarely at night. The pre-oviposition period varies from 10 to 25 days after which the females lay 6 to 16 small, oval and yellowish eggs in one or more rows on both upper and lower surfaces of the leaves. The average incubation period was found to be 7.5 days by Pant. The nymphs, on hatching, are pale green, wingless and about 1/12 inch long and they pass through five moultings. The nymphal period varies from 14 to 25 days. The adults which emerge from the nymphs are pale greenish and about 3/4 inch long, with long slender legs and four jointed feelers.

The period of activity of these insects coincides with the flowering stages of paddy, but the varieties which flower earlier suffer most. It was seen that early varieties like Ch. 10, Gora, Bhutmuri and T 22 were infested by these bugs in early September to such an extent that almost all the ears were affected and the whole ear shrivelled and dried up but the late paddy crop in the adjacent fields was not damaged by these bugs.

CONTROL :

The control measures can be classified as follows :

(a) mechanical and cultural, (b) insecticidal and (c) biological.

(*a*) *Mechanical and Cultural :* Keeping the paddy fields and surrounding areas clear of all weeds, grasses and stubble is an old practice found in our country among the progressive cultivators. But though beneficial, it is not common.

Looking out for eggs, nymphs and adults in August and in September and bagging and destroying them is being advocated. Also brushing the upper half of the plants by dragging gunny bags coated inside with sticky material to catch them and destroying them by twisting the bag at the end of each turn is being practiced on a small scale.

But all these above practices can only be done on a small scale. Also it is no good to try these in a small area when the neighbouring fields are teeming with these insects, as they are sure to come over to the treated area.

Our cultivators also use light traps. Small bonfires are lighted at night near the paddy fields. But by these light traps, only the winged ones are killed and the nymphs escape.

(*b*) *Insecticidal control :* The most common and popular method to control insect pests is by dusting and spraying insecticides. With the functioning of the Plant Protection Departments in all the states, this has become very popular in our country. Various dusts of D. D. T. and Gammexane (benzene hexachloride) are being used to control the rice bugs. The best result has been obtained by dusting B. H. C. 5% @ 25 lbs. per acre. By using a hand duster 3 to 5 acres can be controlled in a day. The best period for dusting is from 3 a.m. to about 9 a.m. The period 10 a.m. to 3 p.m is not suitable for dusting as the flowers may be damaged. While dusting, the operator should move with the wind and should wash his hands immediately after the operation. Unless the hands are washed within an hour blisters are likely to appear.

Among the sprays good results have been obtained by spraying a solution of Guesarol 550 (a D. D. T. preparation) and Pyrocolloid in the

proportion 2:1. About 100 gallons of solution is required to spray an acre of paddy. For 100 gallons of water, about 2.5 lbs. of Guesarol 550 and about 1 lb. of Pyrocolloid is required. The spraying should commence after 12 noon and a fine shower of spray has to be used. If the spray is coarse or if the spraying is given in the morning, the flowers may perish.

In all these cases a residual effect lasts for about 15 to 25 days and thus a severe loss may be averted.

Insecticides should be applied judiciously as the natural enemies which control these bugs are also killed.

(c) *Biological control :* This method of controlling insect pests is not in vogue in our country. Among the insects which control the rice bugs are *Cicindela sexpunctata* Fabr. (predator), *Asopus malabaricus* (pentatomoid predator feeding on adults and nymphs), and certain chalcidoid and proctotrupid egg parasites.

One hopes that research in the right direction will make biological control of insect pests so effective that in future it will be used on a large scale to control not only *Leptocorisa* species but also other insect pests.

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BETTER VARIETIES OF SNAKE GOURD BY INTERVARIETAL HYBRIDIZATION*

By

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The snake gourd, *Trichosanthes anguina*, belongs to a genus which provides vegetables of great nutritive value like *parwal*, and many indigenous drugs to the people of India but unfortunately it has not yet received proper attention in order to improve its characters.

Murti and Patrudu (1934) for the first time attempted an intergeneric cross – *Momordica charantia* (bitter gourd) *X. T. anguina* (snake gourd). They studied the cross up to the F2 generation only. The present study deals with intervarietal crosses of the snake gourd.

Seeds of local varieties were obtained from Mr. R. N. Singh at Kanpur. The snake gourd is a monoecious plant which is cultivated throughout India. Flowers were bagged 24 hours before opening. Pollination was done between 7 and 8 A. M. at the time of the maximum receptivity of the stigma.

The following tables represent the study of F1 hybrid plants along with the two parents.

Table No. 1.

1. Cross N_3 (Dark green) X N_4 (Cress green)

Characters	Parents		F1 (N_3 X N_4)	Remarks.
	Female N_3	Male. N_4.		
1. Fruit colour	Cress green	Water green	Cress green	Cress green is dominant over water green.
2. Fruit length	78. 5 cms.	82. 5 cms.	112. 5 cms.	Great increase in fruit length in hybrid.
3. Fruit thickness	2. 5 cms.	3. 1 cms.	2. 8 cms.	Intermediate.
4. Seed coat colour.	Light brown	Blackish brown.	Blackish brown.	Blackish brown is dominant.
5. Seed size { length	1. 9 cms.	1. 75 cms.	2. 15 cms.	
{ breadth	0. 85 cms.	0. 95 cms.	1. 15 cms.	
6. No. of seeds.	32	43	18	Decrease with the increase in the size of the fruit.
7. Date of sowing.	29. 6. 48.	29. 6. 48.	29. 6. 48.	
8. Date of flowering.	10. 8. 48.	6. 8. 48	19. 8. 48.	
9. Duration of life.	85 days.	130 days.	175 days.	Duration of life increasing in the hybrid

*The article is a part of the thesis submitted in partial fulfilment for the M. Sc. (Ag.) degree in Agricultural Botany of the Agra university.

Table No. 2.

2. Cross N13 (Blackish green) X N5 (Water green)

Characters	Parents		F1 (N13 X N5)	Remarks
	Female (N13)	Male (N 5)		
1. Fruit colour	Black green	Water green	Black green	Black green is dominant
2. Stripe colour	White	Dull	White	White is dominant
3. Fruit length	56.5 cms.	71.5 cms.	75.5 cms.	Increase in fruit length
4. Fruit thickness	2.9 cms.	2.8 cms.	3.1 cms.	Increeace in fruit thickness
5. Seed coat colour	Brown	Blackish brown	Blackish brown	Blackish brown is dominant
6. Seed size { length	1.45 cms.	1.85 cms.	1.7 cms.	
6. Seed size { breadth	0.7 cms.	0.95 cms.	0.95 cms.	
7. No. of seeds per fruit	50	43	42	
8. Date of sowing	29.6.48	29.6.48	29.6.48	
9. Date of flowering	12.8.48	28.8.48	20.8.48	
10. Duration of life (in days)	136	85	160	Increased duration of life in the hybrid.

Table No. 3

3. Cross N8 (Dark green) X N5 (Water green)

Characters	Parents		F1 (N8 X N5)	Remarks
	Female (N8)	Male (N5)		
1. Fruit colour	Dark green	Water green	Dark green	Dark colour is dominant over water green.
2. Stripe colour	Prominent white	Dull	Prominent white	White stripe is dominant.
3. Fruit length	60.5 cms.	85.5 cms.	110.5 cms.	Longer than the parents.
4. Fruit thickness	4.4 cms.	3.6 cms.	5.2 cms.	Thicker than the parents.
5. Seed coat colour	Brown	Blackish brown	Blackish brown	Blackish brown is dominant.
6. Seed size { length	1.65 cms.	1.85 cms.	1.85 cms. }	Hybrid is bold seeded
6. Seed size { breadth	0.95 cms.	0.95 cms.	1.1 cms. }	
7. No. of seed per fruit	58	43	75	
8. Date of sowing	29.6.48	29.6.48	29.6.48	
9. Date of flowering	28.8.48	28.8.48	6.8.48	Hybrid flowers earlier.
10. Duration of life	165 days	85 days	175 days	Duration of life increases in the hybrid
11. No. of fruits per plant	14	18	25	Double and 1½ times more fruits than the respective parents.

The above studies of intervarietal crosses of the snake gourd show that the F1 hybrids are early and more vigourous than their parents, and that they bear more and larger fruits than the parents.

This kind of hybridization can be easily taken up by the illiterate Indian vegetable growers every year. It would prove of great economic importance to them.

The snake gourd is an insect-pollinated crop. Its degenerated wild varieties and *Trichosanthes cucumerina* (wild snake-gourd) are found growing throughout India ; open pollination and continued selfing spoils the better varieties of snake-gourd and can be prevented by the desired controlled pollination as mentioned above.

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COMMONWEALTH'S SHARE IN WORLD GRAIN OUTPUT*

World production of grain has not kept pace with the increase in population since before the war. This is revealed in a summary of statistics just published by the Commonwealth Economic Committee in London.

Recovering quickly after the war, world grain output reached a peak in 1948 of four per cent above the 1937-39 average. Since then it has fallen off and production in the 1951-52 season was only three per cent above the pre-war average. The increase in population over the same period was about 10 per cent. (Figures cited in the summary exclude the Soviet Union and China, for which recent statistics are not available).

Production in the Commonwealth of each of the grains dealt with in the survey (wheat, maize, oats, barley, rye and rice) was higher in 1951 than before the war ; that of wheat had increased by 21 per cent over pre-war and represented over one-quarter of total production (outside the Soviet and China). Barley and oats before the war each represented about one-sixth of total world production and increased output in the Commonwealth raised the figure to over one-fifth in 1951.

The Commonwealth is not a large producer of maize and although production in 1951 was much the same as before the war, the total accounted for some five per cent only of world production. Rye is still of relatively small importance in Commonwealth countries.

Rice Production

The production of rice in the Commonwealth—mainly in India and Pakistan—has been in many years higher than that of wheat and represents a much higher proportion of world production. In 1949 nearly one-half of total rice production outside China was in the Commonwealth, although that percentage fell with smaller Indian crops in 1950 and 1951.

In 1951 the Commonwealth accounted for 46.3 per cent of world rice production compared with the 1937-39 average of 44.5 per cent. Corresponding figures for 1951 and the 1937-39 average respectively for the other grains were : wheat, 28.4 per cent and 24.2 per cent ; maize, 4.7 per cent and 5 per cent ; oats , 23.6 per cent and 17.4 per cent ; barley, 26.6 per cent and 16.4 per cent ; rye, 2.5 per cent and 1.3 per cent.

The summary, in the section dealing with rice, records that of the 98,600,000 acres under rice in the Commonwealth in 1951-52, India accounted for 73,595,000 acres, Pakistan for 22,481,000 acres and Ceylon 1,073,000 acres. The leading country outside the Commonwealth was Indonesia (15,565,000 acres) followed by Thailand (14,468,000 acres) and Burma (9,098,000 acres).

Of the 29,400,000 tons of milled rice produced in Commonwealth countries in 1951-52 India accounted for 20,767,000 tons, Pakistan for 7,745,000 tons, and Ceylon for 341,000 tons. The leading foreign coun-

*Issued by: British Information Services, New Delhi.

tries were Japan, who produced 7,946,000 tons, Indonesia 6,210,000 tons, Thailand 4,752,000 tons, and Burma an estimated 3,400,000 tons.

In its comment on rice production, the survey says that world production of rice (excluding China) which was on the whole well maintained during the war, seems to have shown relatively little change during the past 10 or 12 years, although there may have been some reduction in China.

Indian Output

India and Pakistan, which together account for an overwhelming proportion of the Commonwealth output, have been able to maintain production, in the aggregate, at appreciably above the pre-war level ; in the former country there was a marked expansion in output after Partition, although this was checked by unfavourable weather after 1949-50. The 1951 figure for Pakistan also shows some reduction on earlier years.

In Malaya the reduction experienced during the war years was quickly made good after the war and a further considerable increase was attained after 1948-49 although in 1951-52 the reduction in area led to a decline. In Ceylon, despite the extension of acreage, production in recent years has been very little above the pre-war level.

There have been some considerable changes in the non-Commonwealth producing countries of Asia. In Japan the pre-war level had been regained by 1948-49 but since then output had been on a smaller scale. Production in Thailand, also low at the end of the war, had recovered very rapidly and was greater than the corresponding figure for Burma, formerly much the more important producer. Even in 1951-52 Burmese output was about 1,000,000 tons smaller than before the war. Estimates for Indo-China put total production in recent years at well below pre-war levels. On the other hand, in Indonesia the pre-war level had almost been regained by 1951-52. Figures for both the Phillippines and Formosa have in recent years been larger than before the war.

In the Western Hemisphere both Brazil and the United States reported record production in 1951-52 at about twice the pre-war level. Production was rising, too, in a number of other countries in South and Central America. In Africa the figures for Egypt were in post-war years considerably larger than before the war, though there was a heavy fall in 1951-52, while in Madagascar output is still increasing. Production in Italy has shown considerable recovery in recent years and in 1951 was little below the pre-war level.

Increasing Yield

The survey says that rice, grown under all kinds of conditions ranging from primitive peasant farming to scientific agriculture, showed a wider range of yields per acre than almost any other crop. In the large producing countries of South-East Asia the yield per acre was low. In India yields per acre (5.6 cwt.) are lower than before the war (average yield per acre for 1934-38 : 7.2 cwt.). Efforts are being made there to develop a more intensive system of cultivation and the potentialities of new hybrid strains are also being studied. Ceylon, which has an excep-

tionally low yield per acre of rice (3.7 cwt.), is endeavouring to popularise cultivation by transplantation.

In Italy, Japan and Australia—where Japonica type of rice is grown—careful control of water supply and heavy application of fertiliser give yields of milled rice of more than 20 cwt. per acre.

As regards wheat production in the sub-continent, India with an output of about 10,000,000 tons had been in most pre-war years much the largest wheat producer in the Commonwealth, but lost that position to Canada in 1939. Production was much lower in post-war years but since partition there has been some recovery and in 1950 and 1951 the combined production of India and Pakistan recovered to about the pre-war average.

Of a Commonwealth wheat production of 33,000,000 tons in 1951, Canada accounted for 14,803,000 tons, India for 6,590,000 tons, Pakistan for 3,953,000 tons, and Australia 4,322,000 tons.

SOIL CHEMISTRY. M. Y. SHAWARBI. 420 pages.

John Willey & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 1952. $ 5.00. Reviewed by A. L. Mehring, 4510 Longfellow Street Hyattsville, Md.

Dr. Shawarbi is a native Egyptian, but this book is well written in excellent English. It is easy and interestihg to read. A few typographical and grammatical errors, however, have eluded the proof-reader.

This book is an elimentary text on soil science rather than an exhaustive treatise on soil chemistry, as the name might imply. It includes discussions on soil genesis, soil classification, soil surveys, mapping, soil conservation, and soil literature. It is world-wide in scope. The subjects receiving the fullest treatment are the chemistry of soil reclamation and irrigation. There are no chapters on fertilizers or manures, although the chemical effects on soil of applying various materials is included. Some subjects that a reader might expect to find in a book with this title, but which are not discussed are standard methods of soil sampling and analysis, the use of Ph indicators, the soil bridge and lysimeters, and the effects of placement and granulation of fertilizers on the soil. Quick tests, which have come into such widespread use in this country in recent years, are thought by the author to be of little value, except perhaps in the hands of a genius.

Trained soil scientists will probably take exception to some statements as incomplete or faulty. Practically all of the articles and books in an extensive bibliography were published between 1930 and 1943.

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THE YIELD AND STAND OF WHEAT IN RELATION TO SEED RATE

By

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Among the factors necessary for successful crop production, the seed rate is one the importance of which can never be over-emphasized. Low seed rates are advocated in the belief that thinly sown plants tiller more and are often vigorous and healthy but these desirable points are overweighed when we consider that a thin crop provides space for an increased weed population, which weakens the crop by depriving the plants of their necessary space, light, moisture, air and nutrients. On the other hand thick sowing is recommended to safe-guard against vagaries of climate and soil which cause an increased seedling mortality in the crop but this again is counterbalanced by the increased competition for survival between plants in a thick crop and by the increased danger of diseases spreading in the crop.

Although Hutchinson in 1936 observed that 'Cereals have remarkable abilities of adaptation to the environment in occupying the land to the best advantage', the above considerations necessitate the working out of the optimum seed rate for a crop under any given set of conditions.

The rate of seeding is dependent upon factors like temperature, moisture content and nature of the soil, and the method of sowing. The seed rate in eastern U. P. is usually a little higher than in western U. P. Mitra (1949) has suggested possible causes for this variation as the shorter period favourable to vigorous growth, lower fertility, poor irrigation facilities and greater termite activity in the eastern districts.

EXPERIMENTAL TECHNIQUE :

A field trial was conducted by the author during the year 1949-50 at the B. R. College farm at Bichpuri, Agra to study the response of three varieties of wheat (Pb 591, C13 and *desi*) to three sowing dates (15th October, 30th October and 14th November) at three seeding rates (30, 40, and 50 seers per acre).

The layout chosen for the experiment was the "*Single Split Plot*" design with sowing dates as the main treatments with three replications.

Various growth and developmental characters having a bearing on the yield were studied at successive stages of the life-cycle. The data pertaining to stand and yield are presented here. S1, S2, and S3 have been used as symbols for low (30 seers), medium (40 seers) and heavy (50 seers) seed rate per acre.

EXPERIMENTAL RESULTS :

Seed rate and crop stand : The trend of survival of seedlings at different stages during the life cycle was studied in terms of plants per square

yard and also as the percentage of the actual quantity of viable seed sown. The results are summarized in the table below :

TABLE I

Stand at	Density of seedlings in 1 sq. yard — Stand expressed as the percentage of seed sown			Significant at	Critical difference
	S1 (30 Seers)	S2 (40 Seers)	S3 (50 Seers)		
14th day after sowing ...	81.85	84.89	111.95	1%	18.86
	58.2	44.5	47.0	Not worked out	×
30th day after sowing ...	58.26	62.74	78.15	5%	14.98
	41.8	32.1	34.0	Not worked out	×
Harvest ...	43.03	40.82	54.21	Not signi.	×
	30.6	21.4	22.8	1%	4.6

Stand at 14th Day : S3 produced a significantly (1%) denser crop than S2 or S1 ; between the latter two there was no significant difference, The stand in terms of percentage of the seed sown was higher with S1 than with S3 or S2.

Stand at 30th Day : Statistically the crop stand was significantly (5%) higher with the S3 seed rate than with S2 or S1. The percentage of the seed sown which survived was higher under S1 than S3 or S2.

Stand at Harvest : The density of plants per square yard did not differ significantly between any two seed rates though it was highest with the highest seed rate (S3). But the percentage of survival of the seed sown thinly (S1) was significantly higher that sown more thicky(S2, S3.).

SEED RATES AND YIELD OF GRAIN AND *bhusa* (MDS. PER ACRE).

Grain Yield : The three seed rates did not differ significantly but the highest yield, 22.9 maunds per acre was noted under S1. Under S2 and S3 the yields were 20.6 and 21.6 maunds per acre, respectively.

Bhusa (Straw) *Yields :* This was highest with the high seed rate (S3) followed by medium (S2) and low (S1) in that order, but the variations were not significant. The respective yields were 70.2, 72.8, and 70.8 under S3, S2, and S1.

SUMMARY AND CONCLUSIONS.

1. Higher seed rates show a greater density of plants in the early stages of the life of the crop. However, at harvest there is no difference between the three rates.

2. With a low seed rate, a higher percentage of the seed sown, springs up and survives until harvest.

3. The highest grain yield was secured with a low seed rate followed by heavy and medium seed rates.

4. The *bhusa* yield increased with the increase in seed rate but the extra gain in yield was not much marked.

5. The seed rate in wheat can under suitable conditions be reduced to 30 seers per acre, leading to considerable economy in grain.

ACKNOWLEDGEMENT

The author acknowledges his gratefulness to Dr. N. K. Anant Rao for his able guidance and to Mr. M. D. Dandwate for his help in statistical work.

SCIENTIFIC WAR ON RATS*

It is known that rats not only do damage by devouring, polluting, and destroying considerable quantities of food, etc., they are also spreaders of infection, and carriers of a number of serious diseases that are transmitted to man and animals by means of vermin, with which rats are nearly always badly infested. The plague for instance – one of the most dreadful diseases known to man – is spread mainly by rats.

Life and habits of rats :

In launching a rational anti-rat campaign, thorough knowledge of their life and habits is of the utmost importance. Rats are extraordinarily cunning and suspicious. Attempts to combat them with active poisons like arsenic, strychnine, phosphorus, flourine, thallium, and squill preparations nearly always have the result that, soon after poisoned bait has been put out, they carefully avoid it ; seeing their companions die a rapid and violent death, they at once realize what is wrong. Rats, too, are enormously prolific. One pair of rats under favourable conditions, can multiply to 800-900 during a single year ; and when it is considered that they have a great tendency to migrate it will be obvious that sporadic attacks on them will give only poor results. They must be combated simultaneously over as large an area as possible.

New bacterium discovered :

Potent and active poisons, as already stated, have the unfortunate effect of making rats suspicious. It was realized that, if further progress was to be made, it was necessary that a slow-acting preparation should be discovered – preferably one harmless to man and domestic animals. Such a preparation was found in Denmark. A bacterium which kills mice and rats but not domestic animals was discovered and cultured and after successful experiments, the production was turned over to a company, Bakteriologisk Laboratorium Ratin, Ltd., domiciled in Copenhagen.

Ratin :

Developments were rapid. The morphology, pathogenic properties, and so on, of the Ratin bacterium were investigated, and its place in the bacterial system determined. The scientific name of the bacterium is *Salmonella enteritidis* var. *Danysz*. By peroral infection it produced in rats and mice severe gastro-enteritis, with fatal results after 5-16 days. It was demonstrated that the bacterium was transmitted through infection, not only to the young in the nests but also to other rats, which ate their Ratin-poisoned companions with gusto. Extensive feeding tests proved the bacterium to be relatively harmless to ordinary domestic animals.

Comprehensive tests next showed that, though the rats were destroyed in large numbers, there was still a percentage after each test which survived. In other words, some must be more reesistant than the rest. The firm then resorted to a combined method, known as the Ratin System, which consisted of putting down a rapid standardized squill preparation, Ratinin, about three weeks after distributing the bacterial poison. The surviving rats, whose suspicions had not been aroused by the slow-acting Ratin,

*From the Commercial Section of the Royal Danish Legation, Bombay.

devoured the squill poison without hesitation, and died within 12-14 hours. By this means, total extermination was achieved – or as near total as is practically possible.

RATIN IN FOREIGN COUNTRIES :

It was an ingenious idea, and in the following years the Ratin System aroused interest far beyond Denmark's borders, so that in course of time a number of affiliated companies were set up in most European countries and in the United States, some having their own laboratories while others were supplied with products from the parent laboratory in Copenhagen.

As far as Denmark is oncerned, Ratin is the only bacterial culture approved by the Ministry of the Interior, under various Rat Acts, for use in combating rats.

In other countries, contracts have been concluded between the local offices and a number of large undertakings engaged in agriculture, industry, and trade, as well as warehouses, ports, parks, refuse dumps, and so on. In addition, big experimental campaigns have been undertaken in entire cities and towns in Sweden, Norway, Finland, Czechoslovakia, Syria, the Netherlands, Iceland, and Germany. In Germany, during two and a half years alone (July, 1, 1933 – December 21, 1935), an area with a total of 450,000 farms and cottages was treated by the Ratin System, with fatality varying between 95 and 97 per cent.

In the early 1930s in the city of Beirut, in Syria, there were a hundred deaths a year from plague. The local authorities decided to combat the rats with the Ratin System, with the result that the number of plague cases in the subsequent 3-4 years was reduced to about 40, 20 and six or seven, and the disease eradicated by the end of 30s.

RENT AND INTEREST IN COST OF AGRICULTURAL PRODUCTION.

By

DR. S. P. DHONDYAL

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The normal price of a commodity tends to equal the costs involved in producing it and these costs of production, in turn, consist of the sum total of the price that must be paid for the various goods and services employed in the production of a commodity.

The cost of production includes the following :

1. The price of raw materials.
2. Wages paid to labourers.
3. Salaries paid to the organiser.
4. Normal profits of the entrepreneur.
5. The depreciation of implements and machinery.
6. Insurance and trading charges.

There is a wide divergence of opinion in respect of the inclusion or otherwise of rent and interest in the cost of cultivation.

Rent, according to Ricardo, is 'that portion of the produce of the earth which is paid to the landlord for the original and indestructible powers of the soil'. But in India our land has been in cultivation for centuries and it is difficult to find any land in use on which a cultivator has not made any improvement. It is on this account that it is somewhat difficult to distinguish land from capital.

If a land-owner leases a piece of land to a tenant, how much of the return that goes to the land-owner should be called rent ? An economist would try to seperate the return that is attributable to the improvement called interest from that which results from the productivity of the land called rent in the true economic sense. On the other hand, a business man would call the whole return rent, because he considers the entire land as an investment, giving him on annual income.

Marshall writes, 'That which is rightly regarded as interest on free or floating capital or on new investments of capital is more properly treated as a sort of rent, a quasi-rent on old investment of capital.

Thus interest and rent differ only in degree. Now the question arises whether interest and rent should form part of the cost of production. In this respect there are two main schools of thought.

1. The British economists include rent in the case of tenant farmers only. Orwin writes, 'The rent paid by the farmer has little or nothing to do with the inherent capabilities of the soil, except in particular cases which do not bulk large in the agriculture of the country as a whole, for it represents nothing more than a certain return to the originator of the

enterprise or his successors, on the cost incurred in bringing virgin soils into a condition precedent to the production of food and other agricultural produce.'*

But they do not include interest on capital in the cost of production, as they consider that the cost of a commodity can be nothing more than that which is paid for it. Hence it is calculated in the determination of price. Interest on a cultivator's own capital is considered as an item of profit, whereas interest on the borrowed capital is a charge against profit.

2. The American economists include both rent and interest in the cost of production. They generally do not differentiate between these two terms and consider them as one sum designated as interest on capital invested either in land or any other business.

The Swiss economists include both rent and interest in the cost of production whereas the Danish economists regard them as the residual share of capital after meeting all the expenses of production.

In the light of the views expressed above by different schools of economists, let us consider the problem of inclusion or otherwise of interest and rent from our own point of view.

In the production of a commodity, say wheat, the cost of production consists of all payments that must be made for the use of productive agents employed in its production. If a person starts farming on borrowed capital, he at once pays for the use of land, labour, and capital and also the remuneration to a superintendent for his supervision charges. But our cultivators use some land or capital of their own and are themselves the managers of their holdings and hence confusion occurs in the neglect of rent and interest in the determination of their cost of production.

Our cost of production of a particular crop or livestock product would be incomplete if interest and rent are not included therein even if a cultivator has his own land and capital. According to business principles, he is paying himself as land-owner a sum known as rent and paying himself as capitalist a sum as interest which should form part of cost of production.

Thus in every case whether land or capital is owned by a cultivator himself or borrowed, rent and interest are a charge against cost in the determination of cost of production per unit of a particular commodity.

But it may be pointed out that when we are analysing the standards of efficiency of different farms, i.e. the ratio of input to output within the frame-work of given farm settings, it is worthwhile to omit rent and interest in the cost of production. The reason is that the quantity of land and capital used under a given set of price-cost relationships will depend upon the ability of the cultivator to convert inputs into returns. An intelligent and experienced cultivator gets say 15 maunds of wheat per acre from the same agents of production which are used by another to produce 12 mds. per acre.

*C. S. Orwin : Farming Costs (1921)

PROTECTING CROPS AGAINST PESTS AND DISEASE

By

F. G. ORDISH*

It is a matter of common observation that pests, diseases and weeds attack crops and reduce the harvest. This is not a new state of affairs, as is sometimes thought, as pests have always attacked crops. The Bible contains many references to locusts, mildew and the palmerworm. In the 17th and 18th centuries bunt of wheat (a parasitic disease) tainted flour so much that gingerbread was invented to disguise the taste, and the dancing madnesses of the Middle Ages have been attributed to the ergot disease of rye.

What is new is that we now know we can overcome these troubles by at least one of several methods, which may be either mechanical, biological or chemical. United Kingdom workers have achieved much over a period of many years in this battle against pests. For instance, Jethro Tull investigated "smut" of wheat and led to Tillett's careful experiments in France just 200 years ago. In the mid-19th century John Curtis published his book "Farm Insects" and at the same time the Rev. Mr. Berkeley discovered the fundamental nature of fungus diseases, which led to the control of potato blight and other diseases by copper sprays used on vines. An English firm started by William Cooper, still active today, sold seed dressing for wheat as early as 1856.

The modern era, however, started in about 1860 in the campaign against the Colorado potato beetle in the United States when calcium arsenate was used. This was a damaging spray, and a much better one was found in London Purple, a dye-stuffs by-product. At the turn of the century workers were active in many countries seeking to improve methods of plant protection.

The Board of Agriculture in Britain issued leaflets on control of pests, and pioneers such as Professors Theobald and Salmon gave advice, wrote books and did much experimental work. It was a Scotsman, Professor W. McDougall, who introduced derris root as a commercial insecticide in 1911, which made spraying safe, effective and economic.

NOTABLE ADVANCES

The food crisis of World War I stimulated home agriculture within the United Kindom, and in consequence the protection of crops. Subsequently, notable advances in control were made in the Commonwealth, of which two may be mentioned—Dr. Uvarov propounded the phase theory of locusts which made control by baiting possible, and three serious insect pests of coconuts in Fiji were controlled by biological means.

Even more striking advances were made by United Kingdom workers during the yet more serious crisis of World War II. The three most important were :

*Issued by : British Information Services, New Delhi.

The discovery of the powerful insecticide benzene hexachloride, or "Gammexane". This was first used as a substitute for derris in flea beetle control. Its use was soon extended for overcoming wireworms and cotton insects and others, but its most spectacular success was against locusts. "Gammexane" is more insecticidal than arsenic, and is not poisonous to mammals, at any rate in the quantity used in locust control. It is, moreover, much quicker in action so that it has become the assured basis of the locust campaigns now in progress in the Middle East.

The second United Kingdom discovery was the synthetic hormone selective weedkillers. Such products kill certain weeds and leave grasses unharmed, and are too well known to need description, being everyday articles on farms in many parts of the world. It has been estimated that the use of these products in Britain alone raises the grain crop by half-a million tons yearly, and the benefit to the graminacious crops (cereals pasture and sugarcane) of the world must be enormous.

Thirdly, good pesticides need good machines by which the sprays may be applied to crops. Two United Kingdom firms co-operated to overcome one of the difficulties of spraying field crops – finding, pumping and carting enough water. The solution was to reduce the water to one-tenth of its normal volume and to use an air blast from a fan. This is the principle used in the well-known "Agro" or low volume sprayer.

Systemic Insecticides

Since the war active research has been continued, and I again mention some of the notable advances : Dr. Ripper took schradan, a German organic phosphorous insecticide, and developed systemic insecticides from it. These are substances which are absorbed by plants and which move within them, particularly to the growing tips. Inside the plant they become insecticidal and kill many insects which feed on them : they are thus an invention of considerable promise.

Another United Kingdom advance has been in the way of thinking about the whole subject. There is a large volume of literature dealing with the technical aspects of plant protection, but it is only quite recently that we have begun to think about the economics of the subject as a whole. For example, Britain's Ministry of Agriculture, through its plant pathological laboratory, is correlating its statistics on pest incidence and the Third International Congress on Crop Protection held in Paris in September, 1952, had a well attended section devoted to economics.

The happy co-operation in Britain between government research stations, farmers and industry has reduced losses from pests, and has given for both home use and export a skilled body of workers in the plant protection field, an industry supplying effective spraying and dusting machinery, and a chemical industry with a wide range of effective pesticides.

Disinfectants, pesticides, and weedkillers are an increasingly important branch of United Kingdom exports : they were worth £9 million in the celendar year 1951. All over the world these products are raisng the farmers' yields.

Neither the world nor its farmers can afford to lose crops to pests, and every day more people realise the important part played in the world by the science of plant protection.

ABSTRACT

THE SANTA GERTRUDIS BREED OF BEEF CATTLE AND ITS POSSIBLE USE IN QUEENSLAND.

CHESTER, R. D. AND HOWARD, K. F. 1952. Queensland Agricultural Journal, 75(5), 288-305.

Some 20 new breeds of cattle have been developed in various parts of the world in the past 50 years according to the authors. One of these new breeds is the Santa Gertrudis (3/8 Brahman x 5/8 Shorthorn) developed at the King Ranch in Texas, U. S. A. This Ranch was established in 1852 with a herd of Longhorn cattle. In order to improve the beef qualities of local animals by grading, Shorthorn and Hereford cattle were introduced on the Ranch between 1880 and 1885. This policy continued for about 40 years when it was concluded that the highly graded animals failed to thrive well under local climate and environmental conditions. In 1910 a Shorthorn x Brahman bull was obtained. He was mated with Shorthorn cows ; the resulting progeny were backcrossed with Shorthorn bulls.

As a result of this experience it was decided that 3/8 Brahman x 5/8 Shorthorn was the most desirable combination. This combination appeared to give maximum size, hardiness and the ability to fatten, a high dressing percentage, resistance to heat and insect pests, and practical elimination of the hump. This work was continued until what is recognized as a new breed was developed ; the breed was named Santa Gertrudis.

The cattle are red in colour, only at times showing small amounts of white on the underside and occasionally on the forehead. The skin, horn and hoof pigmentation is red. The cattle are large, with heavy bones. The hair is short and straight, and the hide is loose and thin, with ample neck folds and with a large sheath. The ears are fairly large in size and drooping. A small hump is evident immediately forward of the wither.

The rump is broad and shows only a moderate slope. The thighs are broad and full ; the twist full and deep. The legs are of medium length and set squarely on the body.

The Santa Gertrudis breed, it is claimed, has a high degree of uniformity while still retaining the advantages of the Brahman x Shorthorn cross. They are said to forage well under adverse conditions, to make very good mothers, to be affected very little by high temperatures, to have considerable resistance to insect pests, and to grow at a fast rate.

The authors suggest that while the Santa Gertrudis may not be suited to all areas in Queensland, because of the climate differences, the great need for a breed with the attributes of the Santa Gertrudis in the areas north of the Tropic of Capricorn, in Australia particularly in coastal and subcoastal districts, will be met effectively by this breed.

Breeding plans for Santa Gertrudis cattle suggested for Queensland involve : Firstly, using the bull for crossing with existing breeding herds for the production of a first cross slaughter animal ; or, secondly, using the bulls to grade up existing herds from their present breed status to what amounts to a purebred Santa Gertrudis.

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YOUNG WOMEN TO RECEIVE TRAINING IN HOME ECONOMICS EXTENSION FOR VILLAGE WORK

A group of young women will receive training during the academic year beginning July 7, 1953, in helping village women improve their home and family conditions.

The training will be in the form of a one year course in Home Economics Extension given by the Home Economics Department of the Allahabad Agricultural Institute, for young women over eighteen years of age.

Emphasis will be placed upon the adapting of scientific information to village conditions. This scientific information will include the preparation of nutritive meals for families with low incomes, the use of non-cereal foods, and food preservation. It will also include child care and family living, health and sanitation, the construction of garments for members of the village family, and planning family expenditures on anincome. Supplementing family income by home crafts will also be part of the training, as well as an understanding of soils and crops, animal husbandry, and dairying.

These young women will be taught something about village life and social conditions and an understanding of people and methods of teaching adults and children. This will include some observation and practical work in the villages through co-operation with Extension work.

The course will be limited to fifteen and preference will be given to young women with rural background and experience in village life.

Some scholarships will be available for the course.

BOOK REVIEWS

Farmer and Stock-Breeder Year Book 1953. Published by the Farmer and Stock-Breeder Publications Limited, Dorset House, Stamford Street, London, S. E. 1. 396 pages with numerous illustrations. 77th Edition. Price 10s. 6d. (net).

The contents of this book may be divided into four main sections, as follows : (a) Special Articles, (b) Poultry, (c) Champions of Other Days and the Pedigree Year in Pictures and (d) References.

The special articles include 12 authoritative articles, with more than 130 splendid illustrations. The first two articles discuss certain aspects of international problems of farming ; one is by Mr. Norris Dodd, Director General of F. A.O., who discusses the task of finding food for the increasing world populations and the need for stepping up food production especially in the middle and the far east. The other is by Sir Thomas Dalling, Veterinary Consultant with F. A.O., who discusses the campaign against Foot and Mouth disease at an international level. Current farming practices in Britain are discussed in several articles, written by eminent agriculturists of Great Britain. These papers include Fertilizers for Profit, Four Million Pigs, Landlord and Tenant System, New Cereal Varieties, Safeguarding our Soils, Sheep on the General Farm, and others. The original papers are interestingly written in simple style and language ; they all give some idea of the farming practices and agricultural problems current in Britain, and the efforts at improved food production which are being made.

In the poultry section are two papers, on Deep Litter Systems and Modern Ideas on Henyards.

As the regular show season of 1952 was curtailed due to Food and Mouth disease restrictions, this edition includes a feature called Champions of Other Days, a selection of illustrations of prize-winning animals of many breeds between the two wars. In the Pedigree Year in Pictures (1952) are pictures of this year's livestock show prize winners. Because of the restrictions mentioned, these are primarily pictures of horses, swine, and sheep; only a few cattle are included.

More than 130 pages of important facts and figures are given in the reference section about annual prices; typical rations for cattle, pigs, and poultry ; and so forth.

This book will certainly be of considerable interest to all who are engaged in farming, as well as to those who are making special efforts to step up food production (both animal and vegetable) to meet the current undersupply of food resulting as it has in part from the yearly increases in the world population.

JOHN G. VELU,
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INSECTS - THE YEARBOOK OF AGRICULTURE 1952

Published by United States Department of Agriculture, Washington D. C.

This is undoubtedly a very useful book furnishing valuable information about the harmful and useful insects. The book is the outcome of nearly a hundred years of authentic research work covering multifarious aspects of insects life. Most of the contributions are from the Bureau of Entomology and Plant Quarantine, U. S. D. A. The book contains articles contributed by a number of outstanding entomologists.

The book is divided into 23 sections *viz.*, Introducing the Insects ; How to Know an Insect; Insects as Helpers ; Insects as Destroyers; The Nature of Insecticides ; Applying Insecticides ; Warning as to Insecticides; Resistance to Insecticides ; Fumigants ; Quarantines ; Other Controls ; Economic Entomology ; Insects, Man and Homes ; Insects on Cotton ; Insects and Vegetables ; Insects on Fruit ; Insects on Field Crops ; Pests on Ornamentals ; Livestock and Insects ; Forests, Trees, and Pests ; Insects and Wild Life ; Bibliography and Appendix ; and Some Important Insects. Each of these sections consists of a number of articles which are very well illustrated. The last section dealing with "Some Important Insects" is very informative and beautifully illustrated.

The book is very comprehensive and will prove helpful in combating insect enemies and thus assist in the production of more food, feed, fibre, wood, etc. On account of all this rich information which this book contains it will be welcomed by farmers, students and teachers alike. The book is definitely worth much more than its cost ($2.50).

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